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ABSTRACT

The purpose of this study was to investigate elementary school teachers' (N=236) attributional styles in relation to two indicators of their science teaching performance: teaching method and allocation of time. The following research questions were addressed: (1) How do teachers attribute the causes of success or failure in their science teaching; (2) Does the attributional model help explain science teaching performance in elementary school teachers; and (3) Are the attributional variables predictors of science teaching performance? Data were collected using four instruments to provide information on teacher background, knowledge of science content, causal attributions/dimensions, and choice of teaching role. Results indicate that teachers have distinct attributional styles when explaining the outcomes of their science teaching performance and although significant relationships obtained between attributional variables were generally of a low order of magnitude, teachers' perceptions of their past success in science teaching were moderately related to their attributions to ability in success situations and to their enjoyment of science teaching. Two positive predictors of time allocation were found: (1) the number of science teaching methods completed, and (2) the attribution of successful science teaching to ability. (Author/JN)

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ELEMENTARY TEACHERS' ATTRIBUTIONAL STYLES AND THEIR SCIENCE TEACHING PERFORMANCE

by

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CHAPTER I

THE PROBLEM

Introduction

The apparent failure of educators to maintain effective standards of instruction for large numbers of learners has led to sharp criticism from many quarters, both public and private. It is ironic that these attacks came at a time when the federal government had provided massive funding for curriculum development projects aimed at improving the level of teaching and learning. In the last two decades, the Office of Education and the National Science Foundation have invested many millions of dollars in the development of elementary school science curriculum materials alone (Helgeson, Blosser, & Howe, 1977). These federal funds have made possible the hiring of curriculum development project staffs consisting of scientists, science educators, psychologists, and other learning specialists. The new science programs that have resulted derive their potential for instructional effectiveness from an application of recent developments in educational psychology, e.g., the theories of Bruner, Gagne, and Piaget (Helgeson et al., 1977), and from a more refined rationale for organizing science content around major concepts considered important to the discipline (Lavatelli, Moore, & Kaltsounis, 1972).

The science programs that emerged during the 1960s and early 1970s reflect a major departure from traditional teacher-oriented instruction (Berger, 1972). Thus, the new science projects which have developed comprehensive programs in elementary school science

do not include any student textbooks (Thier, 1970), nor do they advocate reading/lecture teaching methods (White, Raun, & Butts, 1967). Instead, the new curriculum projects present science as an exciting enterprise in which firsthand explorations and the manipulation of materials take the place of the memorization of vocabulary and facts (Butts, 1976). According to Shymansky (1976), these conditions are best met by student-oriented teachers who can serve as facilitators of learning. However, the curriculum development teams of college science educators and educational psychologists may have overlooked some of the barriers to effective science teaching and successful implementation of the new programs that exist in the local classroom (White et al., 1967). Some of these barriers have been identified as including insufficient time and materials, and inadequate science teaching skills (Shrigley, 1977). However, Yager (1978) has stated that factors in teachers such as their self-image and their aspirations may be highly predictive of the kinds of transactions that occur in the science classroom.

According to Schwirian (1969), the new science programs of the 1960s have not been widely adopted because of the negative attitude of the teacher toward science and science teaching. Symington and Fensham (1976) suggest that the obstacle to an acceptance of these innovative science programs may be more one of negative attitudes in the elementary teacher toward science and science teaching than that of teacher acceptance of the nondirective, activity-oriented teaching role required by the new programs. In a study of apprentice teachers' attitudes toward science, Soy (1967) determined

that many entered preservice programs with feelings of inadequacy for teaching science. Of the 200 apprentice teachers interviewed, most said that their high school and college science backgrounds had not promoted feelings of competency for teaching science. Perkes (1975) has demonstrated a high correlation between student teachers' sense of adequacy and their preference for teaching science. However, Hone (1970) asserts that obstacles to effective science instruction such as the teacher's knowledge of science content and the availability of materials and time, are perceived limitations that might not exist in reality. Hone suggests that these barriers to improved science teaching are within the control of the teacher. Teachers can easily improve their background for teaching science by reading elementary science materials. Also, according to Hone, time and equipment shortages can be overcome through the application of more appropriate teaching strategies. Indeed, in a survey of four mid-Western states by Nimmer (1977), most of the 600 elementary school teachers who responded (85% of those surveyed) said they learned to implement their current science program without any formal training. Nelson (1978b) reported that the college science grade point average of preservice teachers was not related to the science achievement of their fifth- and sixth-grade pupils while DiLorenzo and Halliwell (1963) found that groups taught by a science specialist did not register higher scores in science achievement than comparable groups taught by regular classroom teachers. These studies on science teaching in the elementary school, cited above, suggest that a strong science background may not be essential for effective

science teaching on the elementary level. The teachers' perceived sense of adequacy and their affective orientation toward teaching science may be at least as important in determining their science teaching performance (Perkes, 1975; Symington & Fensham, 1976). Educators might be more effective in helping improve science instruction, if they could identify the major factors that contribute to the science teaching performance of elementary school teachers (Yager, 1978).

Attribution theory, a construct developed by social psychologists, may provide a framework for a systematic analysis of how individuals' perceptions are related to their performance (Shaver, 1975). Beginning with investigations by Weiner and others (Weiner, Frieze, Kukla, Reed, Rest, & Rosenbaum, 1971), it has been consistently demonstrated that, in achievement situations, perceptions about the causes of success or failure, called causal attributions, influence a variety of performance indices, such as speed, intensity, persistence, and choice (Weiner, 1972b; 1974; Weiner & Sierad, 1975). The four causal attributions that have been studied most extensively are (a) the individual's ability, (b) the amount of effort expenditure, (c) the difficulty of the task, and (d) the magnitude and direction of one's luck (Weiner, 1979; Weiner, Nierenberg, & Goldstein, 1976). Attribution research has already yielded a large body of valuable information that helps explain the behavior of both teachers and pupils (Ames, 1975; Bailey, Helm, & Gladstone, 1975; Beckman, 1970, 1972; Brandt, Hayden, & Brophy, 1975; Cooper, 1977; Nicholls, 1976; Ross, Bierbrauer, & Polly, 1974; Frieze, Snyder, & Fontaine,

Note 1). The aim of most of these empirical studies has been to explain students' performance in terms of their own or their teacher's causal perceptions. In the present research, however, attribution theory was used to determine the relationship between the causal perception of elementary school teachers and their own science teaching performance.

The survey of precollege science education conducted on behalf of the National Science Foundation (Helgeson et al., 1977) found that the new elementary science curriculum projects have been used or are being used by less than 30% of the nation's elementary schools. The impact of the new science projects has been slight despite accumulating evidence that these programs promote learning in both the affective (Bar-Tal, Leinhardt, & Bar-Tal, 1978; White & Howard, 1970) and the cognitive domains (Carpenter, 1963; Krockover & Malcolm, 1977). The declining state of science in the elementary school curriculum (Maeroff, 1978) would indicate that curriculum development that is concerned with the needs of learners and the structure of the subject matter content, may ignore teacher characteristics that are required for successful program implementation. These factors include the teachers' congruence with the teaching methods required by the program (Symington & Fensham, 1976), their attitude toward science (Schwirian, 1969), and their perception that they can teach science successfully (Perkes, 1975). The elementary science curriculum development projects have achieved their goal to produce materials that organize the fundamental concepts of science in terms of how children learn. However, it is the teacher who must mediate

between the science curriculum materials and pupils. Little is known about how teachers perceive of their own performance as implementors of instructional programs. In order to improve the quality of science instruction and to increase the effectiveness of teacher training programs, we need to know more about teachers' causal attributions and to determine how these perceptions influence science teaching performance.

Statement of the Problem

The major purpose of this research was to apply the Attributional Model of Achievment Motivation to science teaching in order to determine how teachers' causal attributions relate to their science teaching behaviors. Two indices of science teaching performance were measured as dependent variables, namely (a) choice of science teaching method: student-emphasis teaching, student-teacher cooperation, and teacher-emphasis teaching (Berger, 1972) and (b) persistence in teaching science: the amount of time allocated to teaching science.

This research attempted to address the following general questions about the role of causal perceptions as predictors of science teaching performance:

1. How do teachers attribute the causes of their success or failure in their science teaching?

2. Is there a significant relationship among teachers' antecedents, causal attributions, and causal effects, and their science teaching performance as predicted by the Attributional Model of Achievement Motivation?

3. Which teacher antecedents, causal attributions, and causal effects are the best predictors of the teacher's choice of science teaching method?

4. Which teacher antecedents, causal attributions, and causal effects are the best predictors of the teacher's allocation of time to science teaching?

Variables

A. Independent variables. In the present study, factors derived from the attributional model served as the independent variables:

1. Causal attributions: Teachers' perceptions of the causes of success or failure of their science teaching. The four causes of success or failure that are used most often, i.e., ability, effort, task difficulty, and luck were examined.

2. Causal dimensions: "Second order" concepts (Weiner et al., 1978) used by attribution theorists to organize the causal attributions along two dimensions, the internal-external dimension and the stable-unstable dimension.

No measurement items are required. Casual dimensions were determined directly from causal attributions.

3. Antecedents: Past experiences and individual biases.

a. Science background of the teacher--extent of science education in high school, college, and graduate school, and the number of science teaching methods courses in college.

b. Knowledge of science content--objective score on a measure of knowledge of elementary level science curriculum content.

c. Perceived past teaching outcome--teachers' perceptions about the degree to which their science teaching has been successful or unsuccessful in the past.

4. Causal effects: Affective reactions and future expectancy.

a. affective reactions--measurement of how much teachers enjoy teaching science.

b. expectancy shift--the difference between teachers' past expectancy for the outcome (successful or unsuccessful) of their science teaching and their expectancy that their science teaching will be successful or unsuccessful in the future. The two types of expectancy shifts are:

(1) typical expectancy shift--anticipation that outcomes will remain the same as those in the past.

(2) atypical expectancy shift--anticipation that outcomes will change from those in the past.

B. Dependent variables. Two indicators of science teaching performance:

1. Choice of science teaching method: Teacher emphasis, student-teacher cooperation, and student emphasis science teaching roles, as measured by the Predicted Role Measure (PRM), developed by Berger (1972). The PRM is a film-based instrument

> developed to yield information about the roles elementary teachers believe they would use in teaching science. . . . Thus, the PRM enables the participant to predict the roles he perceives for himself as if he were the teacher in the film and allows scoring by the assignment of numerical values to the Likert scale responses. (Berger, 1972, pp. 7-8)

2. Persistence in teaching science: Indicated by teachers' allocation of time for teaching science as measured by the number of minutes of classroom time per week they estimate they spend teaching science. Since in the lower grade levels the minimum time allotment is smaller than in the upper grade levels, this variable was expressed as an index: the decimal (quotient) that results when actual science teaching time is divided by required science teaching time.

Hypotheses

The following hypotheses were tested:

Causal Attributions

1. There are no significant differences among elementary teachers' mean rating scores of four attributions (ability, effort, task difficulty, and luck) as causes of their success or as causes of their failure when teaching science as measured by Science Teaching Situations, a measure of causal attributions.

Antecedents and Causal Attributions

2a. There is no significant relationship between the total number of science content courses completed by elementary school teachers in high school, college, and graduate school, and their causal attributions for success or failure when teaching science

as measured by Science Teaching Situations, a measure of causal attributions.

2b. There is no significant relationship between the total number of science teaching methods courses completed by elementary school teachers and their causal attributions for success or failure when teaching science as measured by Science Teaching Situations, a measure of causal attributions.

2c. There is no significant relationship between elementary school teachers' knowledge of science content as measured by their scores on the Science Test of the National Teachers Examinations (ETS) and their causal attributions for success or failure when teaching science as measured by Science Teaching Situations, a measure of causal attributions.

2d. There is no significant relationship between elementary school teachers' perceptions of the degree to which they have been successful or unsuccessful in their past science teaching and their causal attributions for success or failure when teaching science as measured by Science Teaching Situations, a measure of causal attributions.

Antecedents and Causal Effects

3a. There is no significant relationship between elementary school teachers' perceptions of the degree to which they have been successful or unsuccessful in their past science teaching, and the degree of their expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they

expect their science teaching to be successful or unsuccessful in the future.

3b. There is no significant relationship between elementary school teachers' knowledge of science content as measured by their score on the Science Test of the National Teachers Examination (ETS) and the nature of their expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their science teaching to be succesful or unsuccessful in the future.

3c. There is no significant relationship between the total number of science content courses completed by elementary school teachers in high school, college, and graduate school, and the degree of their expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their science teaching to be successful or unsuccessful in the future.

3d. There is no significant relationship between the total number of science teaching methods courses completed by elementary school teachers and the degree of their expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their science teaching to be successful or unsuccessful in the future.

3e. There is no significant relationship between the total number of science content courses completed by elementary school

teachers in high school, college, and graduate school, and the degree to which they enjoy teaching science.

3f. There is no significant relationship between the total number of science teaching methods courses completed by elementary school teachers and the degree to which they enjoy teaching science.

3g. There is no significant relationship between elementary school teachers' knowledge of science content as measured by their score on the Science Test of the National Teachers Examination (ETS) and the degree to which they enjoy teaching science.

3h. There is no significant relationship between elementary school teachers' perceptions of the degree to which they have been successful or unsuccessful in their past science teaching, and the degree to which they enjoy teaching science.

Antecedents and Science Teaching Performance

4a. There is no significant relationship between the total number of science content courses completed by elementary school teachers in high school, college, and graduate school, and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

4b. There is no significant relationship between the total number of science teaching methods courses completed by elementary school teachers and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

4c. There is no significant relationship between elementary school teachers' knowledge of science content as measured by their scores on the Science Test of the National Teachers Examination (ETS) and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

4d. There is no significant relationship between the total number of science content courses completed by elementary school teachers in high school, college, and graduate school, and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

4e. There is no significant relationship between the total number of science teaching methods courses completed by elementary school teachers and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

4f. There is no significant relationship between elementary school teachers' knowledge of science content as measured by their score on the Science Test of the National Teachers Examination (ETS) and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

4g. There is no significant relationship between elementary school teachers' perceptions of the degree to which they have been successful or unsuccesful in their past science teaching and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

4h. There is no significant relationship between elementary school teachers' perceptions of the degree to which they have been successful or unsuccessful in their past science teaching and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

Causal Dimensions and Causal Effects

5a. There is no significant relationship between the internality of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions, and the degree to which they enjoy teaching science.

5b. There is no significant relationship between the stability of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions, and the degree to which they enjoy teaching science.

5c. There is no significant relationship between the internality of the causal attributions of elementary school teachers

as measured by their scores on Science Teaching Situations, a measure of causal attributions, and their expectancy shifts (typical or atypical), as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their future science teaching to be successful or unsuccessful.

5d. There is no significant relationship between the stability of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions, and their expectancy shifts (typical or atypical), as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their future science teaching to be successful or unsuccessful.

Causal Dimensions and Science Teaching Performance

6a. There is no significant relationship between the internality of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of their causal attributions, and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, and teacher emphasis method.

6b. There is no significant relationship between the internality of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure

of causal attributions, and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

6c. There is no significant relationship between the stability of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions, and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, and teacher emphasis method.

6d. There is no significant relationship between the stability of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions, and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

Causal Effects and Science Teaching Performance

7a. There is no significant relationship between the degree of elementary school teachers' expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their future science teaching to be successful or unsuccessful, and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

7b. There is no significant relationship between the degree of elementary school teachers' expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their future science teaching to be successful or unsuccessful, and their persistence of science teaching performance as measured by their index of time allocation; their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

7c. There is no significant relationship between the degree to which elementary school teachers enjoy teaching science and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

7d. There is no significant relationship between the degree to which elementary school teachers enjoy teaching science and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

The Attributional Model of Achievement Motivation (Weiner, Russell, & Lerman, 1978) and Science Teaching Performance

8a. The 24 selected predictor variables are not significant predictors of elementary school teachers' persistence of science

teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required.

8b. The 24 selected predictor variables are not significant predictors of elementary school teachers' choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, and teacher emphasis methods.

Theoretical Rationale

The New Science Curricula for the Elementary Grades

In the last two decades, instructional programs and materials which are aimed at improving the level of elementary school science teaching and learning have been produced by federally funded curriculum development projects. Leading the development of these projects have been college science specialists, science educators, and educational psychologists (Thier, 1970), who have been primarily concerned with organizing and sequencing science concepts in order to promote the cognitive and the affective development of children (Helgeson et al., 1977). Many of the recent programs that have resulted from these development efforts call for a radical change in traditional educational philosophies and instructional strategies (Berger, 1972). Butts (1976) has described the new programs as presenting science as an exciting enterprise in which firsthand explorations allow children to function as primary investigators.

Berger (1972, 1973), who was associated with the Science Curriculum Improvement Study (SCIS), has defined three teacher roles: teacher emphasis, student-teacher cooperation, and student emphasis. The teacher emphasis role involves traditional teaching methods in which knowledge, concepts, and judgments usually originate with the teacher. The teacher relies heavily on the use of textbooks and student involvement with science materials is limited or absent. The teacher who uses the student-emphasis role allows students to manipulate science materials freely. This teaching method employs questioning to elicit divergent answers. The teacher is nonjudgmental in responding. SCIS, the Elementary Science Study (ESS), and Science--A Process Approach (S-APA) are among the recent programs advocating student-emphasis teaching strategies. The student-teacher cooperation role maintains a middle ground between the two previously described teaching methods. Berger (1972) developed the Predicted Role Measure (PRM) for assessing the teacher's predicted performance in the classroom as defined by these three teaching roles. He found that the teacher-emphasis score can differentiate between teachers who use textbook-centered programs and those who use activity-centered programs (Berger, 1972, 1973).

According to Shymansky (1976), student-centered teachers allow students to experiment freely and to engage in large amounts of pupil-to-pupil talk. Although the teacher may occasionally act as a source of knowledge and an initiator of student investigations, the teacher must also be nondirective in remarks made to students,

and must raise questions that encourage divergent answers and variations in the use of science materials. There is evidence that science programs in which teaching behaviors are less central to instructional transactions and less restrictive of learner behavior can improve the affective orientation of learners (Bar-Tal et al., 1978; White & Howard, 1970), their cognitive development (Carpenter, 1963; Davis, Raymond, MacRawls, & Jordan, 1976; Krockover & Malcolm, 1977; Penick, 1976), and their on-task behavior (Good & Matthews, 1976; Penick, Shymansky, Matthews, & Good, 1976).

However, despite these potential benefits to pupils, the recent science programs have not penetrated into most schools (Helgeson et al., 1977). One barrier to a more widespread utilization of the new elementary school science curricula appears to be the teacher's ability to cope with the demands of these new programs. Empirical studies by Perkes (1975), Shrigley (1977), and Soy (1967) indicate that many elementary school teachers dislike, or feel inadequate about, teaching science. Teachers who feel negatively about science teaching are not accepting of the new science curricular innovations (Strawitz, 1977; Symington & Fensham, 1976). On the basis of their review of the literature, Helgeson et al. (1977) concluded that "the teacher's philosophy regarding what science should be taught and how science should be taught, has a strong influence on the way teachers teach" (p. 20). Shulman (Note 2) asserts that only recently has teacher thinking become an important variable in research on teaching. According to Clark and Yinger

(Note 3), a broad assumption underlying recent trends in research on teaching is that "what teachers do is affected by what they think" (p. 1). Gage (1978) has stated that teachers use their perceptions about their own role, the role of the student, and the nature of education, to form a set of implicit guidelines that govern their behavior at any given time. Gage suggests that these beliefs must be organized into larger theoretical structures before connections between teachers' beliefs and their classroom behaviors can be established. A theoretical construct that can supply the framework for a systematic analysis of teacher perceptions and their relationship to teaching performance is the Attributional Model of Achievement Motivation (Weiner et al., 1978; see Table 1), developed by Weiner (1972a, 1974, 1976) and his colleagues.

Attribution theory, a branch of social psychology, explores how the person uses informational cues in his attempt to find meaning in his own behavior and in the behavior of others (Bar-Tal, 1978). Beginning with investigations by Weiner et al. (1971), it has been consistently demonstrated that, in achievement situations, perceptions about the causes of success of failure, called causal attributions, influence a variety of performance indicators such as speed, intensity, persistence, and choice (Weiner, 1972a, 1974; Weiner & Sierad, 1975). According to Weiner, four causal attributions are used most often by individuals to explain their success or failure in achievement-related situations. Individuals (a) assess their ability, (b) estimate their amount of effort expenditure,

Table 1

The Attributional Model of Achievement Motivation

Antecedents →	Causal Attributions →	Causal Dimensions →	Causal Effects →	Behavioral Consequences
Specific Information (social norms, past experience, patterns of outcome, past success, etc.)	Attributions Ability Effort Task Difficulty Luck Other (mood, fatigue, etc.)	Stability Internality	Expectancy shifts Affective reactions	Intensity, choice, and persistence of performance

Note. Modified from "Affect and Causal Ascriptions" by B. Weiner, D. Russell, and D. Lerman, in New Directions in Attribution Research (Vol. 2), J. H. Harvey, W. Ickes, and R. F. Kidd (Eds.). Copyright 1978 by Lawrence A. Erlbaum Associates, Hillsdale, New Jersey.

(c) consider the difficulty of the task, (d) judge the magnitude and direction of luck. Although these four causal attributions are selected most frequently by experimental subjects, other researchers have identified additional causal attributions such as mood, fatigue, and bias when open-ended responses are solicited (Elig & Frieze, 1979; Frieze, 1976).

Causal attributions and their antecedents. Weiner (1974) states that the perception of an achievement task calls to mind an individual's past experience with that task as well as an array of other pertinent information. (a) Ability--Weiner postulates that attributions to ability are inferred from the number, percentage, and pattern of success experiences at prior achievement activities involving the specific or similar tasks, considered in conjunction with the perceived difficulty of the task. (b) Task difficulty--Subjective task difficulty is postulated by Weiner to be a function of the perceived performance of a reference group at the task. If many others succeed, then the task is "easy"; if few succeed, then it is "difficult." (c) Luck--Generally, the most salient cue for luck attributions is the role of chance in determining the task outcome (e.g., flipping a coin will logically result in luck ascriptions for success and failure). (d) Effort--It might be anticipated that one "knows" how hard one has tried. But this is not the case. Effort and outcome seem to covary. In experiments using tasks whose outcomes were actually random (Kukla, 1972; Weiner & Kukla, 1970), it was found that successful individuals perceive that they tried

harder than unsuccessful individuals. Other cues that are utilized in making effort attributions for success and failure are the incentive value of the goal, and task difficulty (Weiner et al., 1978).

Causal attributions and causal dimensions. The four causal attributions are classified along two dimensions, internality (internal minus external) and stability (stable minus unstable). Effort and ability attributions are internal to the person on the internality dimension whereas luck and task difficulty are external. On the stability dimension, attributions which vary over time, for example, effort and luck, are perceived as unstable, whereas task difficulty and ability, which generally remain the same, are stable (see Table 2). Thus, effort is internal and unstable; ability is internal and stable; task difficulty is external and stable; and luck is external and unstable (Weiner, 1976).

Table 2

Causal Dimensions and Causal Attributions

		Dimension	
		Internal	External
Dimension	Stable	Ability	Task Difficulty
	Unstable	Effort	Luck

Causal dimensions and causal effects. The causal dimensions influence two categories of causal effects, expectancy shifts and affective reactions. Expectancy shifts refer to whether or not a given outcome is expected to recur if conditions remain the same. Affective reactions are the emotions or feelings aroused in the achievement-related situation. It has been postulated that expectancy (Weiner, 1974; Weiner et al., 1976) and to a lesser extent affect (Weiner, 1974; Weiner et al., 1978), are determined by causal dimensions.

1. Expectancy shifts. Weiner et al. (1976) have confirmed the findings of earlier attributional researchers (Fontaine, 1974; McMahan, 1973) that the stability dimension of an individual's attributions affects his expectancy of future succes or failure in a similar situation. Thus, an individual who attributes success to a stable cause (ability or task difficulty) will expect repeated success in similar situations because stable causes are not likely to change. Similarly, attributing past failure to stable causes will lead to the expectancy of future failure in the same achievement situation. The expectancy that outcomes will remain the same on subsequent trials is termed a typical expectancy shift. Attributions to unstable causes (effort or type of student) tend to result in atypical expectancy shifts, i.e., the belief that past outcomes will recur on subsequent trials is diminished. Thus, an individual who attributes success or failure to unstable causes will be less likely to expect the same outcome in the future when encountering a similar task.

2. Affect. Causal attributions and causal dimensions appear to influence affective reactions, but the nature of this relationship has not been clearly established, despite a large number of empirical studies. Earlier results (Weiner, 1972b, 1974) seemed to indicate that internal attributions (ability and effort) modify an individual's feelings abut his performance. Effort attributions were thought to produce more shame for failure outcomes and more pride for successful outcomes than did ability attributions. This conclusion has recently been challenged by Sohn (1977) who found evidence that both success and failure attributed to effort, are followed by a broader range of affective states than either pride or shame alone. Nicholls (1976) asserts that for many, "effort is virtuous, but it's better to have ability." In light of more recent evidence, Weiner (Weiner et al., 1978) has expanded his original conception of affect to include a broader spectrum of emotional feelings. Weiner's recent investigations suggest that specific emotional reactions might result from different causal attributions, irrespective of causal dimensions. It also appears that global affective states might be independent of causal attributions and hinge only on outcomes. Weiner et al. (1978) refer to these as "outcome dependent affects" (p. 71). This conclusion is consistent with earlier findings (Bailey et al., 1975) that affective responses are related more to students' grades on an examination than to causal attributions associated with success or failure outcomes.

The Attributional Model and Science Teaching Performance

The previously described components of the Attributional Model of Achievement Motivation have been shown to influence a variety of performance indicators such as speed, intensity, persistence, and choice (Weiner, 1972a, 1974; Weiner & Sierad, 1975). The present study was concerned with the teacher's performance when teaching science. As discussed above, many elementary school teachers enter the profession with feelings of inadequacy about science which result from negative experiences in high school and college coursework (Perkes, 1975; Soy, 1967). In such teachers, an attributional tendency to internalize failure might develop, i.e., they might conclude that they lack the ability needed to be successful in this area. In a discussion of studies on "learned helplessnes," Dweck and Goetz (1978) have suggested that previous failures in an intellectual achievement situation may be generalized from one domain to another. Thus, teachers may transfer the attributional styles developed during their science learning experience to their science teaching performance. Failure attributions to ability or task difficulty may result in lowered persistence, in avoidance of similar related tasks, and perhaps in interference with new learning (Dweck & Goetz, 1978).

In the present study, two indicators of science teaching performance served as dependent variables. These were (a) choice of science teaching method: student emphasis, student-teacher cooperation, or teacher emphasis teaching methods, and (b) persistence of performance: time allocation for teaching science.

1. Teacher emphasis, student-teacher cooperation, and student emphasis teaching. In the present study, the teachers' choice of science teaching method was related to their attributional style. Science educators who have contrasted teacher emphasis with student emphasis roles (Berger, 1972; Butts, 1976; Nelson, 1978a; Symington & Fensham, 1976) equate teacher emphasis methods with textbook-centered teaching strategies in which reading and telling about science are the major approaches to teaching. Textbook-oriented methods involve teaching techniques that science educators (Butts, 1976; Thier, 1970) regard as being more appropriate for reading programs than for teaching science. Thus, teachers who choose teacher-emphasis roles are essentially avoiding science teaching by substituting reading and telling for science investigations. At the other end of the continuum, teachers who adopt student emphasis roles involve their students in the manipulation of science materials. The student-teacher cooperation role maintains a middle ground between the two previously described teaching methods.

A major hypothesis in the present study was that teachers' perceptions about their science teaching, as reflected in their attributional styles, will correlate with their science teaching performance. It was predicted, for example, that teachers who avoid teaching science by opting for teacher emphasis methods will attribute their lack of success when teaching science to their low ability or to the difficulty of the task (stable attributions). However, teachers whose motivation to teach science is expressed by their

choice of student emphasis methods will explain their unsuccessful science teaching in terms of unstable factors such as a lack of sufficient effort.

2. Time allocation for teaching science. Teachers' performance in science teaching may not only be measured by the method they choose, but also by the amount of time they devote to teaching science in the elementary classroom. Attributions have been shown to influence persistence and intensity of performance in many empirical studies (Diener & Dweck, 1974; Ickes & Layden, 1978; Kukla, 1972; Weiner, Heckhausen, Meyer, & Cook, 1972). Thus, the amount of time allocated to science teaching should serve as an indication of the persistence and intensity with which science is taught. Harnischfeger and Wiley (1976) report that nowadays teachers have great flexibility in allocating their own time in the teaching process. Fisher, Marliave, Filby, Cahen, Moore, and Berliner (1976), at the Far West Laboratory, have found that wide variations exist in teachers' allocation of classroom time. Differences in time allocation are important because they appear to be related to differences in pupil achievement (Dahloff, 1971; Clark & Yinger, Note 3).

If we can discover how teachers' causal perceptions are related to their teaching performance, we should be able to help raise the quality of science education in the elementary schools.

Significance of the Study

A reaction to failure called "learned helplessness" has been identified by Seligman and Maier (1967). Learned helplessness is

characterized by impaired performance that appears to result from the perception that failure is insurmountable and independent of one's responses in an achievement situation (Dweck, 1975; Dweck & Goetz, 1978). These investigators and others (Ickes & Layden, 1978) have interpreted the impaired performance associated with learned helplessness in terms of the Attributional Model. In their empirical studies, impaired performance following failure has been found in subjects who make stable attributions (e.g., to low ability), and who show typical expectancy shifts and negative affect. In contrast, subjects who evince improved performance or increased persistence following failure make unstable attributions (e.g., to lack of effort) and show atypical expectancy shifts and an absence of negative affect. Dweck and Goetz (1978) have found that an individual's level of performance following failure is more closely related to the nature of his causal attributions than to his ability or even to his past history of success. Therefore, teachers' perceptions about the causes of their success or failure in science teaching may have a greater effect on their teaching performance than their knowledge of science content or their ability to adopt student emphasis strategies. The present study attempted to determine the extent to which teachers' knowledge of science content and their causal perceptions and causal effects contribute to their science teaching performance.

Ickes and Layden (1978) have demonstrated in a series of investigations that learned helplessness occurs more frequently in women

than in men. If the relationships predicted by the attributional model are applicable to elementary school teachers (who are mostly women), this study should have important implications for teacher training and for the development of curriculum materials to be used by classroom teachers in the implementation of science programs. Increasing the amount of science content or the number of teaching methods courses in the professional development of elementary teachers may not raise teaching performance significantly unless training can lead to a change in teachers' attributional styles.

Subjects in research investigations have altered their performance responses when others supplied them with causal attributions that were different from their own (Maracek & Mettee, 1972; Weiner & Sierad, 1975). Similar evidence, gathered in an educational context (Chapin & Dyck, 1976; Heckhausen, 1975) suggests that the manipulation of attributions (e.g., retraining to ascribe success and failure to effort) can lead to increased persistence and improved methods of performance. The present research attempted to identify the factors that contribute most to teachers' science teaching performance. Of major interest was the relationshp between attributional styles and science teaching performance. If the findings of this study can establish a significant positive relationship between causal perceptions and science teaching, this information can be used in manipulating attributions in the training of teachers to teach science.

Definition of the Terms

1. Causal attributions. How individuals explain outcomes of achievement-related situations. The four causal attributions commonly employed by Weiner (1972a, 1974) and others (Elig & Frieze, 1979; Ickes & Layden, 1978) are effort, luck, ability, and task difficulty.

2. Expectancy. Predicted outcome in an achievement-related situation.

3. Expectancy shift. The difference between an individual's expectancy for his past performance outcome and his expectancy for future outcome at the same or a similar task.

a. Typical expectancy shift. Predicting success following success or failure following failure.

b. Atypical expectancy shift. Predicting success following failure or failure following success (e.g., gambler's fallacy).

4. Internal-external dimension. A characterization of causal attributions according to whether they are internal to the person (ability and effort) or whether they are environmental (task difficulty and luck).

5. Outcome. Success or failure in an achievement-related situation.

6. Stable-unstable dimension. A characterization of causal attributions according to whether they may be considered to vary with time (luck and effort) or whether they are unchanging (ability and task difficulty).

7. Teaching methods. Limited to the science teaching roles that are dependent variables in this study: teacher emphasis role, student-teacher cooperation role, and student emphasis role, as defined by Berger (1972, 1973):

a. Student Emphasis role: The students are central to instructional transactions. Typical behaviors for the teacher using Student Emphasis roles are: teacher allows students to experiment freely with materials, teacher asks questions that will allow divergent answers, teacher is nonjudgmental in his responses, teacher encourages different and unusual uses of the equipment, teacher allows a large amount of pupil-to-pupil talk, and teacher encourages the use of science materials.

b. Student-Teacher Cooperation role: The teacher retains a central role in the development of concepts and the initiation of demonstrations and experiments, but teaching strategies are strongly influenced by children's responses and reactions to the lesson. Typical behaviors for the teacher while using Student-Teacher Cooperation roles are: teacher encourages the children to work with him in designing experiments, teacher builds on children's disagreements to develop concepts, teacher helps pupils to make new inferences, teacher listens to pupils' responses as a guide to future study, and teacher provides opportunities for children to design and carry out experiments.

c. Teacher Emphasis role: The teacher's role is central to instructional transactions. Typical behaviors for the teacher

while using the Teacher Emphasis role are: teacher defines a concept, teacher demonstrates, teacher asks convergent questions (questions leading to a particular answer), teacher makes judgmental comments on answers to questions, and teacher disseminates facts or knowledge or uses other authority such as books.

8. Teacher performance. Limited to choice of teaching methods and time allocation for science instruction as defined in the present study.

9. Time allocation for science teaching. A score which is calculated by dividing the teacher's estimate of average class time spent on teaching science (length of average lesson x frequency of lessons per week) by 75 minutes per week for the primary grades or by 150 minutes per week for the intermediate grades, and by multiplying the quotient by 20, the number of weeks in the school term.

Limitations of the Study

The following limitations will be placed on this study.

1. Participants in this study will be a volunteer sample from an available population of elementary school teachers. It will not represent the total population of elementary school teachers.

2. This study will be limited to the kind of teaching performance indicated and will not represent a cross section of behaviors used by teachers teaching elementary science.

3. The knowledge of science content measured in this study will be limited to the areas indicated and will not represent all possible content areas relevant to the teaching of elementary science.

4. The findings of this study will be limited to results obtained from administering the instruments in the order indicated.

Organization of the Study

This study is presented in five chapters. Chapter I includes an introduction, the statement of the problem, the definition of the terms, the significance of the study, limitations of the study, and organization of the study. Chapter II presents a review of related research and literature. Chapter III describes the subjects, materials, and procedures. Chapter IV sets forth the findings of the study. Chapter V presents the summary, conclusions, implications, and recommendations for further research.

CHAPTER II

REVIEW OF RELATED RESEARCH AND LITERATURE

The purpose of this chapter is to present a summary of the research and literature related to the following topics:

1. A review of attribution theory applied in an educational context
2. Teachers' attitudes toward science and science teaching
3. Science teaching performance:
   a. Science teaching methods
   b. Time allocation for science teaching
4. Attribution theory and performance change.

Attribution Theory Applied in an Educational Context

Attribution theory is a branch of social psychology whose primary concern is to explain how individuals use informational cues to attribute causes for their own behavior and for the behavior of others (Bar-Tal, 1978). Beginning with investigations by Weiner et al. (1971), it has been consistently demonstrated that, in achievement situations, perceptions about the causes of success or failure, called causal attributions, influence a variety of performance indicators such as speed, intensity, persistence, and choice (Weiner, 1972a, 1974; Weiner & Sierad, 1975). Causal attributions also influence a person's future outlook and emotional reactions (Shaver, 1975). Four causal attributions are used most often in explaining achievement-related outcomes. The individual (a) assesses his

ability, (b) estimates his effort expenditure, (c) considers the difficulty of the task, and (d) judges the magnitude and direction of luck. Weiner (1974) states that perceptions related to these four attributions are based on antecedents which include past experience with the specific task as well as an array of other pertinent information. Causal attributions represent cognitive processes that mediate between these antecedents and a series of consequents.

According to Weiner (1979), the four causal attributions are classified along two causal dimensions, internal-external (internality) and stable-unstable (stability). On the internality dimension, effort and ability are internal to the person while task difficulty and luck are external. On the stability dimension, effort and luck are perceived as unstable, while task difficulty and ability are stable.

Causal dimensions influence two categories of causal effects, expectancy shifts, and affective reactions (Weiner, 1972a, 1974, 1976). Expectancy shifts refer to whether or not a given outcome is expected to recur if conditions remain the same. Weiner et al. (1976) have confirmed earlier findings (Fontaine, 1974; McMahan, 1973) that the stability dimension of individuals' attributions affects their expectancy of success when a similar situation occurs in the future. Individuals who make attributions to stable causes (ability or task difficulty) will expect future outcomes in similar situations to remain the same. Attributions to unstable causes (effort and luck) tend to diminish the belief that past outcomes will recur on subsequent trials.

Causal attributions and causal dimensions also appear to influence affective reactions, but the nature of this relationship has not been firmly established, despite a large number of empirical studies. Earlier results (Weiner, 1974; Weiner et al., 1972) seemed to indicate that the internality dimension produced feelings of pride or shame about performance outcomes. Weiner's more recent investigations show that a host of specific emotional reactions might result from the different causal attributions, irrespective of their causal dimensions (Weiner, 1977; Weiner et al., 1978). Weiner also suggested that individuals' general affective states might be independent of their causal attributions and hinge only on outcome ("outcome-dependent" affects). The theoretical framework of causal attributions, causal dimensions, causal effects, and performance, has been called the Attributional Model of Achievement Motivation (Weiner et al., 1978). Weiner (1974, 1976, 1979) has asserted that the attributional model may be used to explain performance in classroom settings.

For example, a large number of studies have demonstrated a link between students' academic achievement and their perceptions of causality. Arkin and Maruyama (1979) measured the causal attributions of over 200 college students who were asked to rate the influence of ability, effort, task difficulty, and luck on their performance after a final examination. Successful students attributed their performance more to stable factors than did unsuccessful students. The stability of the students' attributions was negatively

correlated with anxiety. In a laboratory experiment, Weiner et al. (1972) induced continual failure at a digit-symbol substitution task administered to 39 male high school students. Following five repeated failure experiences the subjects rated the perceived causes of their failure among the four causal attributions. Although the performance of all attribution groups increased as a result of practice at the task, subjects who scored high on the attributions of failure to low ability or to task difficulty (stable attributions) performed more slowly than those who scored low on attributions to stable causes. Conversely, students who scored high on their attribution of failure to bad luck or low effort (unstable causes) performed more speedily than those who scored low on attributions to unstable factors. The implications of these studies is that an individual's causal attributions for success and failure are related to both affective and performance outcomes.

Some empirical studies have emerged which have utilized attribution theory to explain how teachers assign responsibility for learning achievement in the classroom (e.g., Ames, 1975; Beckman, 1972; Brandt, Hayden, & Brophy, 1975; Cooper, 1977). Brandt et al. found that student performance outcome may also influence teachers' evaluations of their own ability. In their study, teachers who taught successful students had a high estimation of their own ability, but teachers did not take responsibility when students performed poorly. Also, there is evidence that attributions for their students' performance may affect teachers' future behavior.

Cooper and Burger (Note 4) presented 62 precertification teachers with a stimulus situation in which a student did poorly or well on an examination, followed by a list of causal attributions for the students' failure or success. After each attribution, the teachers were asked to predict how they would behave toward their students after each success or failure situation. When teachers attributed student failure to unstable but internal causes (i.e., lack of effort), they expressed greater intention to criticize their students. Teachers expressed greatest likelihood to praise students when successful student performance implied a relatively large teacher role. When student performance outcome was attributed to causes external to the student, e.g., to the teacher or the task, teachers reported the greatest intention to change the way they taught when students did poorly and the least intention to change the way they taught when students did well.

The attributional model has been applied extensively in educational contexts because it is a powerful tool for explaining choice and persistence of performance (Weiner, 1976). However, a review of the research indicates that investigations of the attributional process in classroom settings have generally centered on the causes of student performance. Studies that investigate teachers' causal cognitions in relation to their own classroom performance appear to be missing from the literature. However, according to Clark and Yinger (Note 3), a broad assumption underlying recent trends in research on teaching is that "what teachers do is affected by

what they think" (p. 1). Gage (1978) has stated that teachers use their perceptions about their own role to form a set of implicit guidelines that govern their behavior at any given time. Gage suggests that these beliefs must be organized into larger theoretical structures before connection between teachers' beliefs and their classroom behaviors can be established. In the present research, the Attributional Model of Achievement Motivation (Weiner et al., 1978) served as a theoretical construct to help explain how teachers' antecedents, causal attributions, causal dimensions, and causal effects influence aspects of their own teaching performance. One area of instruction that merits intensive investigation is science teaching in elementary schools.

Teachers' Attitudes Toward Science and Science Teaching

In the elementary school curriculum, science appears to be an instructional area in which many teachers have a negative attitude or feel inadequate about the task of teaching (Perkes, 1975; Shrigley, 1977; Soy, 1967). For example, Soy found that at Iowa State College fewer than 8% of the apprentice teachers elected to take science as their area of specialization. Of the 200 apprentice teachers who were interviewed, most said that they believed that children were interested in science but that they themselves were not. The teacher trainees said that science courses are hard and that their high school science background did not prepare them to succeed in college science. Indeed, respondents to Vinci's (1966) survey of 177 regular teachers in 25 New York City schools ranked their preference to teach science far below reading and mathematics.

Perkes (1975) sought to identify background factors in teachers that are related to their preference and their feelings of adequacy to teach elementary science to their classes. He administered three instruments to 52 prospective elementary school teachers at the University of California at Davis: (a) a questionnaire requesting biographical information such as a description of the types of high school and college science courses they had taken, a scale indicating the relative degree of difficulty they experienced in studying science, a rank ordering of their preferences to teach the content areas of the elementary curriculum, and a scale reflecting their sense of adequacy to teach science; (b) an Omnibus Personality Inventory (OPI) to provide descriptions of the subjects' personality characteristics; and (c) the Methods and Procedures Examination (MPE) to assess the respondents' grasp of the methods and processes of science. The results indicated that the teachers' sense of adequacy and their preference to teach science were closely related to each other. However, none of the 13 OPI personality scales related significantly to teacher background factors, to their understanding of science processes and methodologies as measured by the MPE, or to their preference or feelings of adequacy to teach science. Also, although the MPE scores were related to the science background of the teachers, there were no important relationships between the respondents' MPE scores and their sense of adequacy or their preference for teaching science. Furthermore, the respondents' preference and adequacy scores related negatively to their self-evaluation

of difficulty in their previous science studies and also, to their tendency to elect additional college level science courses. Perkes concluded that the high correlation obtained between perceived difficulty in past science courses and adequacy and preference for science teaching, indicates that the teachers' preference to teach science is based on the prognostication that they will be able to teach science successfully. According to Perkes, the negative relationship obtained between the teachers' scores for preference and adequacy to teach science, and their tendency to elect additional science courses in college, indicates that the teachers who are most in need of upgrading their preparation to teach science are least likely to seek to improve their knowledge of science content and methodology by opting for additional coursework.

Shrigley (1977) asked teachers in his study to list factors that contributed to inadequate science teaching. In 78% of the responses teachers indicated that lack of materials and time were most responsible for the avoidance of science teaching. Another 10% of the teachers said that they lacked skills for teaching science. However, Hone (1970) asserts that obtacles to effective science instruction such as the teacher's knowledge of science content and the availability of materials and time, are perceived limitations that might not exist in reality. Hone suggests that these barriers to improved science teaching are within the control of the teacher. Teachers can easily improve their background for teaching science by reading elementary science materials. Also, according to Hone,

time and materials shortages can be overcome through the application of more appropriate teaching strategies.

Therefore, it appears that for many elementary school teachers, negative perceptions about their ability to master science content and feelings of inadequacy for coping with the task of teaching science are related to their tendency to avoid science teaching. Thus, teachers' perceptions about the causes of their success or failure at teaching science may contribute as much to their science teaching performance as their knowledge of science content or the availability of materials and time for teaching science. The present study investigates the relationship between teachers' causal cognitions and two aspects of their science teaching performance: persistence and choice.

Science Teaching Performance

In the present research project, the two indicators of science teaching performance are (a) persistence in science teaching defined as the teachers' index of time allocation for science teaching, and (b) choice of teaching method defined in terms of three teaching roles: student emphasis, student-teacher cooperation, and teacher emphasis teaching methods. Teaching method and allocation of time are two aspects of classroom science instruction which are largely controlled by teachers and which are subject to substantial variability in practice.

Science Teaching Methods

During the 1960s and 1970s millions of federal dollars were expended on the development of elementary science curriculum materials aimed at raising the level of science education in the nation's schools (Helgeson et al., 1977). These programs were built on newly established constructs in educational psychology and updated scientific knowledge. To implement the new programs science educators introduced teaching methodologies that involved students in firsthand explorations with science materials (Butts, 1976). The most frequently used elementary science programs, e.g., the Science Curriculum Improvement Study (SCIS), Science: A Process Approach (S-APA), and Modular Activities Programs in Science (MAPS), reflect the new emphasis on the methods and processes of science. In these programs laboratory work has been tailored to meet children's needs and interests; and the reading of textbooks and memorization of facts have been largely replaced by student-directed learning experiences (Berger, 1972).

The large scale improvement in the science curriculum that developed during the last two decades led to the delineation of a variety of instructional strategies that may be applied by the teacher. For example, Carpenter (1963) identified two contrasting methods for teaching science. The textbook-recitation method is an extension of the reading program. Science is taught by reading a basic textbook and by answering questions found in the text. At the other extreme, the problem method for teaching science is

based on classroom demonstration and experimentation. Study guidelines are based on questions or problems expressed by the students. Carpenter (1963) matched two groups of fourth-grade classes on the basis of intelligence, age, and sex. Classes which served as experimentals were taught by the problem method. The controls were taught by the textbook method. Both groups studied a unit in physical science for a three-week period. A t-test comparison of means on an examination administered to both groups at the end of this period revealed that the group which engaged in science activities scored higher in factual material. The roles of the two matched groups were then reversed for a second three-week period during which a unit in biological science was studied. Again, the group which learned by engaging in science activities outscored those who pursued the textbook-based method. Carpenter found that the difference in teaching methods did not significantly influence the scores of pupils who were ranked in the top 25% of their class. However, when he made a t-test comparison of the mean scores achieved by students who ranked low in general academic achievement, those in the activity method group had a significantly higher score than those who learned by the textbook-recitation method. Carpenter concluded that science teaching methods based on experimentation are particularly effective for slower learning children.

Shymansky (1976) defined two science teaching patterns similar to those presented by Carpenter: Teacher-Structured Learning in Science (TSLS) and Student-Structured Learning in Science (SSLS).

TSLS teachers tell their students what to do, or how to do an activity. They praise and evaluate students for their ideas or behaviors. In contrast, the SSLS teaching strategy calls for the teacher to adopt a nondirective and nonevaluatie teaching role. SSLS is characterized by shorter periods of student-teacher interaction. Shymansky and his colleagues at the Florida State University (Good & Matthews, 1976; Penick, 1976; Penick et al., 1976; Shymansky & Mathews, 1974) applied an observational instrument, the Science Curriculum Assessment System Classroom Interaction Categories (SCAS), in an intensive investigation of the effect of TSLS and SSLS on student behavior during science lessons.

Good, Matthews, Shymansky, and Penick (1976) sought to determine whether children with different cognitive development characteristics tend to exhibit different classroom behaviors in either a TSLS or SSLS environment. These researchers observed that when the teacher is judgmental or tells students what to do, or how to do an activity, nonconservers are easily diverted from productive activities with science materials to observing the teacher and to following the teachers' directions. Teacher-structured teaching strategies were also found to discourage Piagetian conservers from engaging in creative activities not originating from the teacher. Good et al. (1976) found that where the teacher provides no directions or praise, students exhibit more on-task behavior and few behaviors that are unrelated to the lesson. Instructional strategies that are student-structured seem to benefit most, students of average

or lower ability (Shymansky & Matthews, 1974). In their study, fifth-grade students who ranked lowest on the California Short Form Test of Mental Maturity and on a test of fourth-grade achievement made the greatest gains in science achievement (as measured by the TAB Inventory of Science Processes) in a nondirective and nonevaluative classroom setting. Nine observers who collected data daily on six students who were in the study, observed that student-structured teaching methods result in fewer teacher-student interactions and more student time spent on science activities. Thus, research that contrasts TSLS with SSLS has demonstrated that student behaviors are related to the behaviors of their teachers. When teachers are nonevaluative, students interact more with each other and with science materials. When teachers are judgmental and give directions, students, particularly those who are slower in cognitive development, spend less time on-task.

The new curriculum materials and methods have had a positive effect on cognitive and affective learning, and on the classroom behavior of children (Bowyer & Linn, 1978; Lowery, Bowyer, & Padilla, 1980). For example, Bowyer and Linn (1978) evaluated the cumulative effects of a six-year SCIS program on scientific literacy defined as knowledge of the basic concepts of science and an understanding of the nature of science. Their study involved over 500 sixth graders in several rural midwestern schools. Two groups of subjects were identified. Those who had completed the six-year SCIS program in its entirety served as experimentals. The controls were students

who had received science instruction that was based on a textbook series. Both groups spent the same amount of time on science per week and were educationally equivalent in terms of intelligence and socioeconomic status. A scientific literacy test (SLT) consisting of a battery of nine pencil-and-paper tasks was developed to give evidence of an understanding of science concepts. The tasks required students to perform mental operations so that they could not rely on guessing or rote memorization. The children with SCIS experience performed significantly better on most tasks of the SLT. The investigators concluded that long-term SCIS experiences lead to a more successful assimilation of fundamental science concepts and a greater capability for problem solving. Furthermore, there is evidence that the SCIS program also appears to enhance the attitude of children toward science. In a more recent article, Lowery et al. (1980) reported the results obtained when a random selection of 110 of the sixth-grade children in the previous study (Bowyer & Linn, 1978) were administered the Projective Test of Attitudes (PTOA), a three-part measure of attitudes toward science: science in general, experimenting, and the scientist. The results indicated that, compared with the controls, six years of the SCIS program had a positive and significant effect upon the attitudes of both boys and girls toward the field of science, experimenting, and scientists. However, boys in the SCIS program had a significantly more positive attitude toward all three categories of science than girls.

The S-APA project emphasizes science skills and processes taught

through investigations and activities rather than the memorization of facts or concepts (Davis et al., 1976). Davis et al. sought to investigate whether a process-oriented program like S-APA influences the achievement of children. Their study compared students in two schools in the southern part of the United States. The experimental school had adopted the S-APA program while in the control school, the Silver-Burdett textbook series was in use. The achievement of both groups on the Metropolitan and SRA standardized achievement tests in mathematics, reading, and science were compared. Also, in order to evaluate the development of process skills through the S-APA program, the evaluation included the Torrence Test of Creative Thinking (TTCT). The results of the investigation indicated that on all grade levels there were no significant differences in subject matter achievement as a result of participation in the S-APA. However, S-APA students were significantly superior in divergent thinking and problem solving as measured by the TTCT. Therefore, it appears that even where activity oriented programs do not foster the development of science achievement specifically, they may influence other areas of cognitive or affective learning. There is evidence, for example, that the SCIS program provides a classroom environment which promotes self-concept development. Krockover and Malcolm (1977) have reported that pupils in grades 3 through 6 who were enrolled in a SCIS program were found to show greater improvement in two clusters of the Piers-Harris Scales (Intellectual and School Status and Physical Appearance and Attributes) than children in programs based on textbooks.

However, despite the educational advantages that these programs have demonstrated surveys of broad geographic areas indicate that they have not achieved widespread acceptance by most practitioners teaching science in elementary schools (Helgeson et al., 1977). Gullickson (1978), who surveyed principals and teachers in four midwestern states, found that the new science programs were used by only 25% of the teachers and in only 37% of the schools that responded. The National Science Foundation's Science Education Databook (Buccino, Dessart, Levine, & Rivkin, 1980) records that nationwide the new science curriculum materials are in use in only 10 to 13% of the primary school classes. Textbook series continue to be the most frequently used instructional materials for teaching science.

In summary, it appears that recently developed science curriculum projects are superior to textbook-based programs in helping students (a) attain knowledge of science concepts and processes, and (b) develop more positive attitudes toward themselves and toward science in general.

Measurement of Science Teaching Methods

Berger (1972) devised the Predicted Role Measure (PRM), a simulation instrument to measure teachers' patterns of adherence to three strategies for classroom interaction in science teaching: student emphasis, student-teacher cooperation, and teacher emphasis method. In the teacher emphasis method, knowledge, concepts, and judgments usually are initiated by the teacher. The teacher relies heavily on the use of textbooks and student involvement in

"hands-on" activities is minimal. In the student-teacher cooperation role, the teacher retains a central role in the development of concepts and the initiation of activities but shares the decision-making process about future study and experimentation with the children. In the student emphasis role, decisions about what will occur in the classroom are decided by the students. The teacher is nonjudgmental about student ideas and about the use of materials.

The PRM was devised to eliminate the need for classroom observations in measuring teaching behavior in the science classroom. Major problems with observational techniques which Berger sought to overcome were: (a) the time needed for observation, (b) the expense of obtaining broad-based information, (c) the inability of observers to assess a uniform teaching situation across subjects. The PRM utilizes a color motion picture film of teachers in a variety of interactions with students. Teachers viewing the film are asked to record their degree of agreement or disagreement with six statements about the method they would use in each of nine science teaching situations. The results of the PRM scores of the 184 elementary school teachers in Berger's sample indicated that teachers respond less with teacher emphasis than with student-teacher cooperation or student emphasis in their predicted roles. Berger also found that teachers' responses on the PRM correspond to actual classroom performance. Thirteen teachers were administered the PRM after they were observed while teaching by two trained observers at least once a month for a period of six months. The observers recorded

152 situations similar to scenes shown in the film. The predicted behaviors of the 13 teachers matched their classroom performance 74% of the time.

Berger's sample of 184 teachers included 64 teachers who had received training in student emphasis (SCIS) methods and 120 teachers who had not. Of the 120 teachers who had not participated in these programs, 73 indicated that they taught science from textbooks and 47 reported that they used student-centered methods. A multivariate analysis of variance showed that there was a significant difference between the PRM scores of these two groups of teachers. This difference was due primarily to the low teacher emphasis scores of the activity-centered group. Berger also compared the PRM scores of pre-institute and post-institute teachers. Significant differences were obtained between the teacher emphasis scores of these two groups. After institute training, teacher emphasis scores were significantly lower. Thus, the PRM was able to distinguish between activity-centered and textbook-centered teachers as well as between those who had participated in student emphasis method training and those who had not. However, in this study, teacher background variables, i.e., years of teaching experience, sex, number of college science courses, and enjoyment of science teaching, were not related to the PRM scores of the teachers.

Thus, the PRM appears to be a reliable and valid predictor of the teachers' classroom behaviors. In the present study, the PRM was used to measure an indicator of science teaching performance, the teachers' choice of science teaching method.

Time Allocation

In addition to teaching method, another aspect of classroom science instruction which reveals teacher variability is that of allocation of time to science. The Boards of Education of New York City and New York State have set standards for the allocation of classroom time to the various content areas of the elementary curriculum, including science (New York City Board of Education, n.d.; The University of the State of New York, 1978). According to these guidelines, teachers of grades kindergarten through 3 should allocate approximately 75 minutes each week to science. One hundred fifty minutes of science instruction per week are suggested for grades 4 through 6. However, Harnischfeger and Wiley (1976) have found that the time standards set by local school boards and districts throughout the United States are not rigorously applied. Indeed, they and Fisher et al. (1976) at the Far West Laboratories determined that there are wide variations between classrooms in the amount of time teachers allocate to school subjects. This conclusion is supported by the findings of Vinci (1966) in the study cited earlier. Vinci found that when teachers were asked to select from among five choices a time allotment for science that best described their instructional practices, some indicated that they spend over 90 minutes per week teaching science while others said that they allocate no time at all to science. Vinci's (1966) data are based on a self-report questionnaire. Other methodologies that have been applied in the study of time as a metric include observational techniques

(Dahlhof, 1971; Wiley, 1973) and teacher log keeping (Fisher et al., 1976). Harris and Yinger (Note 5) conclude that time estimates provided by teachers are likely to be liberal. Fisher et al. (1976) and Dahlhof (1971) found that the allotment of classroom time is a variable mainly controlled by the teacher.

The empirical evidence that has been accumulated as a result of the investigations of Fisher et al. (1976), Dahlhof (1971), and Wiley (1973) leads to the conclusion that the amount of classroom time spent at learning is related to student achievement in a given subject matter area. In fact, Harris and Yinger (Note 5) assert that "time as a dependent variable can be considered a proxy for learning" (p. 15). Many science educators believe that the national decline in science achievement can be attributed to recent trends to reduce the amount of time devoted to science in our elementary schools (Maeroff, 1978).

Attribution Theory and Performance Change

It is a major premise of the present study that teacher antecedents and causal cognitions are related to these two indicators of science teaching performance: choice of teaching method and time allocation for teaching science as predicted by the Attributional Model of Achievement Motivation (Weiner et al., 1978). Such a relationship may have important implications for the improvement of teaching.

Already there is evidence that changes in maladaptive causal perceptions can lead to improved academic performance. For example,

in a field study by Dweck (1975), the effects of attributional retraining were demonstrated in children selected for their attributions of failure to lack of ability. Initially, these children were found not to persist in their efforts to solve mathematics problems. In a series of verbal retraining sessions, Dweck taught these children to attribute failure to lack of effort. As compared to similar children in the control group who did not get attributional retraining, the change in attributional style was accompanied by improved mathematics performance. Weiner and Sierad (1975) manipulated their subjects' attributions during a laboratory experiment. Subjects were first classified according to their achievement needs. Subjects low in achievement needs attributed failure to lack of ability while subjects high in achievement needs attributed failure to lack of effort. All subjects experienced the same four failure trials, but those in the experimental condition also received a placebo pill that was supposed to interfere with their performance. The placebo served to alter the attributional preferences of all the experimental subjects. Those subjects who were high in achievement needs and who based their expectancy for future success on internal, stable attributions (high ability) now made external, stable attributions (the placebo). With a lowered expectancy for success, the high achievement needs experimentals performed with less intensity than the controls. On the other hand, low needs achievement subjects usually expected failure as a result of their internal stable attributions (lack of ability). The placebo did

not alter their expectancy of failure but did remove responsibility to external causes. These subjects performed with greater intensity under experimental conditions. As compared with the control, the effect of the placebo in the experimental condition was to heighten the performance of the subjects who were low in achievement needs and to depress the performance of high needs achievement subjects.

Therefore, research efforts involving attributional retraining have implications for science educators. For example, attributional studies have demonstrated that when changes are induced in the locus of causality, or the stability of subjects' attributions, an improvement in their performance can be obtained. Similarly, training teachers to alter their causal attributions may produce an improvement in their science teaching performance. However, factors that motivate some teachers to allocate more time to science or to adopt more innovative teaching methods need to be identified. The present study seeks to examine the relationships between teachers' background factors and attributional styles, and these two indicators of science teaching performance. Significant findings may have important implications for the improvement of teacher training and for the development of science materials that can be applied more effectively in elementary science instruction.

Summary

The purpose of this chapter was to review the related literature and to develop background and direction for the present study. The four areas reviewed in this chapter were:

1. A review of attribution theory applied in an educational context

2. Teachers' attitudes toward science and science teaching

3. Science teaching performance:

    a. Science teaching methods

    b. Time allocation for science teaching

4. Attribution theory and performance change.

The literature indicates that recent research in science teaching has led to the development of a large number of science curriculum projects. The newer science curricula encourage students to use science materials freely in laboratory-type investigations. The trend to "hands-on science" has shifted the central role in classroom transactions away from the teacher and closer to the student. Science educators have found that students gain in cognitive skills and in affective outcomes when student emphasis methods are applied in science teaching.

Yet the literature reviewed has indicated that the new curriculum materials and teaching methods of the recent elementary science projects have not been embraced by teachers in the schools. In addition, the research cited indicates that teachers are not allocating adequate time to teaching science. These two science teaching performance criteria (a) teaching method and (b) time allocation are the dependent variables in the present study. From the research reviewed outlining the applications of attribution theory in educational settings, it is hypothesized that classroom performance is

influenced by inferences that students and teachers make about the causes of success and failure. The present study will examine possible relationships between the attributional styles of teachers and their science teaching performance.

CHAPTER III

SUBJECTS, MATERIALS, AND PROCEDURES

The purpose of this chapter is to report on: (a) the subjects selected for the study, (b) the materials used for measuring teacher antecedents, causal attributions, causal effects, and performance variables, (c) the procedures used in the administration and scoring of the materials, (d) statistical procedures employed in data analysis, and (e) the pilot study.

Subjects

The target population in this study was defined as all elementary school teachers in self-contained classrooms of grades kindergarten through 6 who were currently employed in the New York City public school system. Elementary school teachers in classrooms where science was regularly taught by a specialist or by a cluster teacher were not included.

In addition, teachers in programs requiring more than one-half hour of instruction in a foreign language were not selected for the study since a major commitment to bilingual studies may be expected to influence science teaching in a manner different from that of regular programs that do not have this constraint.

The subjects in this study were 236 elementary school teachers, 210 females and 26 males, in four boroughs of New York City (excluding Staten Island) who volunteered to participate in the study. They had an average of 12.033 years of teaching experience and a

mean age range of 41 through 50 years. The mean grade level taught was 3.093. The sample consisted of 141 teachers of grades kindergarten through 3 and 95 teachers of grades 4 through 6.

Selection of Subjects

In order to work with teachers in the New York City system, the support of the United Federation of Teachers is necessary. The investigator met, therefore, with Mr. Abe Levine, Vice President for Elementary School Teachers. A formal letter of support for this research project was granted subsequent to this meeting (see Appendix A).

Dr. Alan Blumner, director of the Office of Educational Evaluation, Board of Education of the City of New York, approved this research project for the entire city (see Appendix A). Letters indicating their willingness to cooperate in the research project were received from district officials in seven community school districts. These letters were not included in the appendices in order to insure that the identity of the participating districts will remain confidential. The total number of elementary school teachers in these seven school districts as estimated in the Board of Education of the City of New York 1975-1976 School Profiles (issued February 1977) was 4,462.

The investigator sought to recruit a sample of approximately 240 elementary school teachers from the accessible population. "In multivariate research (multiple regression, for example), the sample size should be several times (preferably 10 or more times)

as large as the number of variables" (Roscoe, 1975, p. 184). In the present research, the 24 variables tested in the hypotheses were studied. Four school districts representing the four boroughs of New York City were selected out of the seven districts who sent letters of cooperation. In selecting the four participating districts the investigator attempted to achieve a representative sampling of New York City community school districts in regard to the following demographic factors: district size; student ethnic, racial, and socioeconomic factors; and student performance on standardized achievement tests.

In August 1979, the researcher met with Mrs. Gloria Weinman, Special Assistant for Educational Services of the United Federation of Teachers. The purpose of this meeting was to develop a method for the selection of teachers that would meet recognized standards for educational research (Borg & Gall, 1979) and at the same time be consonent with Union policies concerning its members. A general procedure for recruiting teachers through New York City school districts was formulated at that meeting.

The procedures for the recruitment of teachers for the study were as follows:

1. The investigator recruited teachers on a district-wide basis. A listing of all the schools in each district, including names of principals, and school addresses with phone numbers was collected from each of the four participating school districts.

2. A letter was then sent to each principal (see Appendix A). The letter contained a general description of the project and

the selection procedures, and requested the school's Organization Sheet. In addition, each principal was asked to indicate, on the Organization Sheet, which classes were taught by a science specialist or cluster teacher; which classes were conducted in a foreign language for more than one-half hour each day; and which personnel were not regular classroom teachers. Principals who did not respond within two or three weeks were phoned to encourage their cooperation. The letters to the principals also included enclosures documenting the support of their district superintendent, the Board of Education, and the United Federation of Teachers.

3. The Organization Sheets listed teachers by name, classroom, and grade level. School administrative personnel indicated which of the classes listed were in bilingual programs and which were taught science by a cluster teacher or science specialist.

4. In the four participating school districts, 658 regular classroom teachers were found to be eligible to participate in the study. They did not teach bilingual classes and science was not taught to their students by another teacher.

5. The subjects were obtained by contacting all eligible teachers in each of the four districts by mail. The letter requesting each teacher to participate in the study included the following information: (a) a brief description of the project, (b) the length and nature of the session in which they would participate, and (c) assurance of compensation for the subjects at the Union per session rate (see Appendix A). In addition, the participating teachers

were informed that they would receive free science teaching aids for coming to the after-school session.

6. A response card and stamped-addressed envelope were included with the letter to each teacher (see Appendix A).

In the pilot study, approximately one-third of those teachers eligible to participate volunteered for the testing session. It was therefore decided that in order to ensure the required sample, every eligible teacher from the four selected school districts who volunteered to participate would be utilized as a subject in the main study.

In the main study, 658 eligible teachers were identified and contacted. Of these, a total of 236 teachers who responded and attended the research sessions, served as the sample population

Materials

The following four instruments comprise the materials that were used in the study.

1. The Teacher Background Information Instrument (see Appendix B) was developed by the investigator to measure several independent variables as well as one dependent variable, time allocation, as follows: (a) Demographic and personological characteristics of the teacher (items 1 through 4). Information on the teachers' years of teaching experience, age, sex, and grade level was obtained for descriptive purposes. (b) Teacher antecedents (items 5, 6, 7, and 9). Data were obtained on the number of science content courses

in high school, college, and graduate school; participation in science teaching methods courses; number of science teaching methods courses; and teachers' perceptions of their previous science teaching outcomes. (c) Allocation of classroom time to science teaching (items 10 through 14), a dependent variable. (d) Causal effects. Data were collected on: affect, enjoyment of science teaching (item 8), and expectancy shift, the teachers' expected improvement in science teaching as measured by expectancy for past science teaching outcome (item 15) subtracted from future expectancy for science teaching outcome (item 16).

2. The Science Test of the Common Examinations of the National Teachers Examinations (ETS) was selected to measure the teacher antecedent, knowledge of science content. The National Teachers Examination is a secure test and therefore the Science Test is not duplicated in the appendices of the present study.

3. Science Teaching Situations (see Appendix C), a modified version of an instrument developed by Ickes and Layden (1978), was used to measure causal attributions and causal dimensions which served as independent variables.

4. The Predicted Role Measure (see Appendix D), an instrument developed by Berger (1972), was selected to measure the teachers' choice of science teaching role, a dependent variable.

These instruments are described in greater detail in the following sections, organized in terms of the variables that were measured.

Measures of Teacher Antecedents

1. Teacher science education background (see items 5, 6, and 7 in the Teacher Background Information Instrument, Appendix B). These items were designed to provide information about the number of science courses that teachers completed on the high school, college, and graduate levels (item 5) and the number of elementary science methods courses completed in undergraduate and graduate schools and in inservice workshops (items 6 and 7).

There were three subscores for item 5, one each for high school, college, and graduate levels. The subscores consisted of the total number of courses on each level. Item 6 was not tallied. It was included to reduce teacher bias in answering item 7. The total number of science methods courses completed served as the score for item 7.

2. Teachers' perception of previous science teaching outcome (see item 9 in the Teacher Background Information Instrument, Appendix B). Teachers rated the degree to which they perceived that their past science teaching was successful or unsuccessful on a scale of 1 through 8. The rating scale was anchored at the poles by "extremely unsuccessful" (1) through "extremely successful" (8).

Teachers who perceived their previous science teaching as unsuccessful scored 1 (for extremely unsuccessful) through 4 (for slightly unsuccessful), according to the number that they circled. Teachers who perceived their previous science teaching as successful circled 5 (for slightly successful) through 8 (for extremely successful).

3. Measure of the teachers' knowledge of elementary science. The Science Test of the Common Examinations of the National Teacher Examinations (NTE), (Educational Testing Services (ETS), Princeton, New Jersey), was selected to evaluate the subjects' competence on basic concepts and generalizations of science. Separate advisory part scores were obtained for science. The reliability for the science scores on 30 items ranges from .79 and .81, as obtained from Kuder-Richardson estimates. The science test is normed at a mean of 6, and a standard deviation of 1. Buros' (1978) Mental Measurements Yearbook reports scores as ranging from 3 to 9.

A major consideration in the selection of this instrument was its validity for sampling knowledge of science content of elementary school teachers in the New York City system. This measure of teacher knowledge of elementary science adequately represented the domain of elementary science content as encompassed in Curriculum Bulletins, issued by the Bureau of Curriculum Development of the New York City Board of Education. The most recent science curriculum guides available from the city are as follows:

Bulletin #17, Science, Grades K-2, 1965-1966

Bulletin #11, Science, Grades 3-4, 1966-1967

Bulletin #6, Science, Grade 5, 1968-1969

Bulletin #6, Science, Grade 6, 1971-1972.

The items also corresponded to the topic areas outlined in Science for Children, K-3 and 4-6 (University of the State of New York, 1963). The investigator arranged for a temporary loan of this secure instrument (Form K). An analysis by topic area showed that the

science test of the Common Examinations overlaps substantially with the science content covered in the New York State and New York City curriculum guidelines.

The investigator contacted Dr. Richard Majetic of ETS to arrange for the use of this secure test in the present study (see Appendix A for letter of permission). ETS provided 50 test booklets, 200 answer sheets, and technical data. For the purposes of this study, ETS separated the Science Test from the other parts of the Common Examinations. In scoring the Science Test, the number of correct items was tallied.

Measures of Causal Attributions and Causal Dimensions

For this study, Science Teaching Situations was developed by the investigator to measure teachers' causal attributions for the success and failure of their science teaching (see Appendix C). These rating scales were modelled after an instrument used by Ickes and Layden (1978, p. 130). Science Teaching Situations consists of eight statements, each of which describes a classroom situation involving a science teaching outcome. Each statement is followed by four possible causes which could explain the outcome of each situation. Four of the situations (A, D, F, and H) describe classroom teaching outcomes which are positive (success) and the other four situations (B, C, E, and G) describe those which are negative (failure). For each situation, the four possible explanations represent the four causal attributions (ability, effort, task difficulty, and luck).

The instrument design in the present study is different from Ickes and Layden's (1978) in two respects. First, their measure covers a wide range of social and achievement situations. In the present study, all items are limited to the achievement-related context of science teaching only. Thus, the instrument used in the present study is limited to the measure of attributional styles in science teaching situations. This increase in instrument specificity may be expected to enhance its stability. Second, in Ickes and Layden's measure, the four possible causes responsible for each outcome are defined along the internality and stability dimensions without specific reference to the causal attributions. However, in the instrument that was used in the present study, one of each of the eight hypothetical situations refers specifically to the four causal attributions of the attributional model, either ability, effort, task difficulty, or luck.

1. Measures of teachers' causal attributions in Science Teaching Situations. Each causal attribution was measured by two scores; one score ranging from 0 to 4 measured the probability of that attribution being the cause of success in each of the four positive situations, and the other, also ranging from 0 to 4, measured its probability as a cause of failure in each of the four negative situations. Thus, each of the two scores for each of the four causal attributions could range from 0 through 16, depending on how probable each teacher saw each attribution as a cause of either success or failure, as follows:

Causal Attributions	Outcomes: Success	Outcomes: Failure
Ability	0 through 16	0 through 16
Effort	0 through 16	0 through 16
Task difficulty	0 through 16	0 through 16
Luck	0 through 16	0 through 16

2. Measures of teachers' causal dimensions. The scores for success and failure on each of the four causal attributions obtained through the Science Teaching Situations instrument were used to measure the causal dimensions of internality (internal minus external) and stability (stable minus unstable) in the following manner: Scores for the internal dimension were determined by summing the scores for ability and effort. Scores for task difficulty and luck were summed to yield scores along the external dimension. Scores for internality were derived by subtracting the scores for the external dimension from the scores for the internal dimension for success and for failure. Similarly, for the stable dimension, scores for task difficulty and ability were summed while for the unstable dimension scores for luck and effort were summed. Scores for stability were derived by subtracting the scores for the unstable dimension from the scores for the stable dimension for success and for failure. Scores for the stability and the internality dimensions could each range from -32 to 32, as follows:

Causal Dimensions	Outcomes: Success	Outcomes: Failure
Internal (ability + effort)	0 through 32	0 through 32
External (task difficulty + luck)	0 through 32	0 through 32
Internality (Internal - External)	-32 through 32	-32 through 32
Stable (ability + task difficulty)	0 through 32	0 through 32
Unstable (effort + luck)	0 through 32	0 through 32
Stability (Stable - Unstable)	-32 through 32	-32 through 32

Measures of Causal Effects

According to the Weiner model of achievement motivation (Weiner et al., 1978), causal effects mediate between causal dimensions and performance. In the present study, two types of causal effects, affect and expectancy shift, were studied.

1. Affect for science teaching (see item 8 in the Teacher Background Information Instrument, Appendix B). A measure of the degree of enjoyment of science teaching was obtained on an eight-point rating scale from (1) extremely enjoyable through (8) extremely unenjoyable. This item was modeled after items used by Frieze et al. (Note 1) to test student attributions and the attributional model.

2. Expectancy shift (see items 15 and 16 in the Teacher Background Information Instrument, Appendix B). Degree of past and future expected success in science teaching were rated on eight-point scales. Past expectancy (item 15) was rated from (1) for extremely successful through (8) for extremely unsuccessful. Future expectancy (item 16) was rated from (1) for extremely unsuccessful through (8) for extremely successful. These items were modeled

after items used by Frieze et al. (Note 1) to measure causal effects. The direction of the rating scales between items 8 and 9 and between items 15 and 16 in the Teacher Background Information Instrument (see Appendix B) were reversed in order to reduce the possibility of a response set.

Teachers who expect successful outcomes from their science teaching (past or present) score 1 (for extremely successful) through 4 (for slightly successful), according to the number that they circle. Teachers who expect unsuccessful outcomes from their science teaching (past or future) score 5 (for slightly unsuccessful) through 8 (for extremely unsuccessful), according to the number that they circle. Item 15 (expectancy for past science teaching outcomes) is compared with item 16 (expectancy for future science teaching outcomes) in measuring each teacher's expectancy shift. Teachers whose expectancy for future science teaching outcomes remains unchanged when compared with their past expectancies (i.e., success following success, or failure following failure) have typical expectancy shifts. For typical expectancy shifts, scores range between 1 and 4 (success following success) or between 5 and 8 (failure following failure) on both items 15 and 16. Teachers whose expectancies for future science teaching are changed as compared with their past expectancies (i.e., success following failure or failure following success) have atypical expectancy shifts. The degree of expectancy shift is calculated by subtracting the score on item 15 from the score on item 16. Thus, the possible range of scores for expectancy shift is from -7 through 7.

Measures of the Dependent Variables

In the present investigation, the dependent variables are measured in terms of two indicators of science teaching performance: persistence, as measured by the teachers' time allocation for teaching science, and choice, as measured by their predicted teaching method.

1. Time allocation for science teaching (see items 10 through 14 in the Teacher Background Information Instrument, Appendix B). The teachers were asked to estimate the amount of time they spend teaching science to their students, in order to provide a measure of their persistence in teaching science. Methods that have been used for measuring time allocation in other research investigations include classroom observations and teacher log keeping (see e.g., Fisher et al., 1976). These methods require a large staff and are considered too time consuming and too expensive for a dissertation project. Furthermore, Vinci (1966), who conducted a study involving a similar population of teachers, has demonstrated that meaningful information about the allocation of classroom time to science teaching can be generated by teacher self-report items.

Item 10, a yes-no forced choice, measures the teachers' involvement in teaching science. Teachers who indicated that they were not teaching science were told to omit items 11 through 14. Instead, they scored a zero for their time allocation to science teaching. The time allocation for respondents who indicated that they were teaching science was determined from their responses to items 11 through 14.

Item 11 is a measure of the number of weeks during the school term in which the teachers are involved in science teaching. Respondents listed the major topics that they taught during the school term. For each topic they listed, the respondents estimated the time, in weeks, devoted to that topic. The total number of weeks of science instruction per term is determined by summing the number of weeks devoted to each major topic.

Item 12 is a measure of the estimated number of days per week in which science is taught by the respondents to their students. Item 13 measures the estimated length of a typical lesson in minutes. Item 14 is a measure of the estimated number of minutes per week that the respondents allocate to teaching science. The product of the teachers' responses to items 12 and 13 yields an estimate of their allocation of time to science teaching in minutes per week.

Internal consistency. Item 14 is included in order to get a measure of the internal consistency in the teachers' responses to items measuring time allocation. If the teachers are arriving at a reliable estimate of their time allocation to science teaching, the product of item 12 x item 13 should be equal to their response to item 14. Thus, the degree to which these values correlate is an indication of the internal consistency of the time allocation measure, i.e., since item 12 x item 13 = item 14, their product-moment correlation should approach 1.00. In the present study, the product of the mean scores for items 12 and 13 was lower than the mean score for item 14. A Pearson product-moment correlation of .601 was obtained.

Index of time allocation. New York State recommends a program of instruction for elementary schools on the bases of the Education Law, Regulations of the Commissioner of Education, and Regents' Rules. There is no formal syllabus covering the kindergarten curriculum, but the handbook, Science for Children, K-3 does contain many concepts and activities for this level. The length of the school day for grades 1 through 6 must be five hours, excluding lunch (Commissioner's Regulation). The elementary schools in New York State are required to provide instruction in 14 Common Branch areas, including science. The approximate weekly time allotment for science in the elementary school curriculum is 5% in the primary grades (1-3) and 10% in the intermediate grades (4-6). An addition 5% time allocation is allowed for health and safety education on all grade levels (The Standard School Curriculum in New York State, The University of the State of New York, Albany, New York, 1/1/78). This may be interpreted to mean that in any five-day week, science should be taught for 75 minutes in the primary grades and for 150 minutes in the intermediate grades. Because science is taught in kindergarten, kindergarten was considered to be a primary grade in this study. The New York City Board of Education follows the State's suggestions for allocating time to science and other curriculum areas. However, time allocation is less exact by New York City Board of Education standards. The New York City guidelines make greater allowance for overlapping areas of content and provide for variations in time which depend on many factors: the children's

needs, interests, abilities, previous experiences, maturity; materials and facilities available; the overall curriculum plan of the school. Given this amount of leeway, it is quite likely that time allocations for science teaching will fluctuate widely both between and within schools. Nonetheless, New York City recommends a 10% time allocation for science and health teaching in the primary grades and 15% time allocation for these content areas on the intermediate level (from Curriculum Bulletin #55-56 series, Curriculum Development in Elementary Schools, New York City Board of Education). When the health education component is removed from these percentages, it can be seen that the City's time allocation requirements are essentially a more flexible version of the State's requiements for science education.

In this study, time allocation for teaching science is calculated by dividing the teacher's estimate of minutes per week (item 12 multiplied by item 13) by New York State's estimate of minutes per week for primary (K-3) or intermediate (4-6) grades. The resulting quotient, expressed as a decimal to the nearest thousandth, is then multiplied by the estimated total number of weeks (item 11) to yield an index of time allocation for teaching science.

K-3 Time Allocation Index =

$$\frac{\text{(times per week) x (minutes per lesson)}}{\text{75 minutes per week}} \times \text{total number of weeks}$$

4-6 Time Allocation Index =

$$\frac{\text{(times per week) x (minutes per lesson)}}{\text{150 minutes per week}} \times \text{total number of weeks}$$

If teachers are following the guidelines of New York City and New York State, this index should approximate 20, the total number of weeks in the school term.

2. Choice of science teaching method in the Predicted Role Measure (PRM) (see Appendix D). The PRM was designed by Berger (1972) to predict the methods elementary school teachers would apply when teaching science. The PRM is used to measure the teachers' choice of science teaching method. The development of the PRM was the major purpose of Berger's study, Predictions of Teaching Behaviors by Teachers of Elementary School Science. This device involves the use of a 16mm. color film and an accompanying pamphlet of statements about teaching situations in the film. The film used by Berger includes nine scenes which are used to predict teaching behavior.

According to Powell (1978), observation instruments may not be reliable measures of teaching performance because they rate teachers across different instructional contexts such as grade level, classroom organization, and teaching situations. The use of a motion picture is a preferable alternative to observational instruments because it provides a uniform behavioral situation to which subjects can respond. Also, Berger (1972) asserts that a motion picture can serve as a better stimulus situation than written measures because participants can see and hear factors that are not easily represented through printed media.

The film chosen by Berger for the development of the PRM was Don't Tell Me, I'll Find Out (SCIS, 1968). This film was

reconstructed so that it could be stopped just before the teacher in the film made a decision. The participants were then asked, by indicating their degree of agreement with each of six statements, to predict their teaching behaviors as if the situation in the film were happening to them. The PRM was designed to measure predicted teaching roles in three categories. These categories were: teacher emphasis role, student-teacher cooperation role, and student emphasis role.

Development of the items. For each of the nine scenes in the film, a series of six statements was developed representing two each of the three teacher roles. Data were gathered concerning teacher agreement with each of the six statements using a five-cell Likert rating scale. The PRM was applied to 184 teachers in groups in the states of California, Massachusetts, and North Carolina.

The six statements accompanying each scene were derived from a larger pool that was submitted to eight judges who were asked to order the statements serially from teacher emphasis, to student-teacher cooperation, to student emphasis. The agreement of the judges' ranking of statements was determined using the Kendall coefficient of concordance (W), a statistical method of interrater reliability applicable where there are more than two judges. Reduction to six statements for each scene was carried out by discarding responses in which there was a large amount of interrater disagreement until W values above the arbitrary level of .90 were obtained for all statements. A split-half measure of reliability of .84

was obtained by administering the PRM to a group of 23 graduate education students.

The scoring procedures developed by Berger (1972, p. 49) were adopted for use in this study. Scores for the Predicted Role Measure were generated by assigning a value of 4 to complete agreement with each item; a value of 3 to slight agreement with each item; a value of 2 to each neutral agreement; a value of 1 to each slight disagreement; and a value of 0 to each complete disagreement. Thus, the score for each item could range from 4 to 0. The two items for each of the nine scenes corresponding to teacher emphasis statements were added together to yield a total called Teacher Emphasis score (range 0 through 72). The same procedure was repeated for Student-Teacher Cooperation scores (range 0 through 72) and Student Emphasis scores (range 0 through 72). Thus, because there were two items for each role for each of the nine scenes, there were 18 representative scores for each role of predicted behavior.

Validity. Two types of validity were determined by Berger. The content validity was established by having eight judges rank the possible responses and achieving an agreement of $W > .90$, as described above. Predictive validity was established by observing 13 teachers at least once a month for a period of six months in order to determine if the predicted behaviors reported by respondents match behaviors they would exhibit in the classroom. The observer filled out a check list which indicated the kind of behavior (student emphasis, student-teacher cooperation, or teacher emphasis) observed

during an elementary school science lesson. The check list was developed from the PRM situations. The observer was instructed to check one or two of the most typical behaviors teachers were observed to use. The PRM was administered to the teachers after the observations had been made. The predictive validity for each teacher was calculated from the ratio of teacher-observer agreements to the total number of observations by the observer. This ratio had a range of .40 to 1.00, with a mean predictive validity of .74.

Item analysis. A nonparametric distribution, the Kolmogorov-Smirnov (KS) two-sample test was used to evaluate the individual statements. Fifty high scores and 50 low scores were selected from each set of teacher emphasis, student-teacher cooperation, and student emphasis scores. Only 5 of the 54 statements failed to discriminate between high and low scores on the PRM.

The results of the PRM scores of 184 elementary school teachers reflected their role preferences. The distributions of the role scores for the three scores were normally distributed and had approximately equal variance. From the means and standard deviations of the role scores, it was concluded that teachers characteristically respond with less teacher emphasis than student-teacher cooperation or student emphasis in their predicted roles. Indeed, teacher preference for teacher emphasis statements emerged last. However, student-teacher cooperation and student emphasis role preferences depended to a great extent on the particular situation.

Each situation of the PRM required two responses for each role orientation. A check for internal consistency was made by an examination of the frequencies of each pair score. KS two-sample tests indicated that differences in response frequencies existed in 14 of 27 pairs of statements. These differences were attributed to teacher preference for nonjudgmental responses.

The three role scores were tested for independence using Bartlett's test. The student-teacher cooperation variable was not independent of the other scores. The correlation coefficients among the three role scores are:

Teacher Emphasis/Student-Teacher Cooperation	0.441
Student Emphasis/Student-Teacher Cooperation	0.316
Teacher Emphasis/Student Emphasis	0.051

Statistically significant differences were found in the Teacher Emphasis Role scores with activity-centered teachers scoring lower than textbook-centered teachers.

Summary. The testing of the reliability and the validity of the PRM led to the following results:

1. A split-half reliability of 0.84 was obtained based on 23 graduate student participants.

2. The content validity established by eight judges exceeded a 0.90 correlation.

3. The mean predictive validity obtained by comparing roles scores on the PRM with classroom observation of 13 teachers over a six-month period was 0.74. Student Emphasis validity was higher and Teacher Emphasis validity was lower.

4. Item analysis of the 54 statements within the PRM indicated that five statements did not discriminate between high and low scores.

5. Teachers were more student oriented and less teacher oriented in their predicted roles.

6. Teachers using activity-centered science methods differed in their predicted behavior from teachers who used textbook-centered science methods in being less teacher oriented in their predicted behavior.

The validity and the reliability of the Predicted Role Measure in the current study. A feasibility test of the PRM was performed with a group of elementary apprentice teachers at Fordham University in March 1979. A copy of the research proposal was then sent to Berger for his comments on the use of his instrument for measuring teacher performance in this study. Also, a request was made for written permission to use the PRM as indicated in this proposal. Permission and approval for the use of the PRM in this study were obtained from Berger (Appendix A).

In the fall of 1979, the PRM and the three other instruments used in the present study were tested further with a group of seven teachers at a private day school. Following the second feasibility study, a pilot study was conducted in December 1979 involving 61 elementary public school teachers from one school district, to establish the reliability of the PRM. As a result of an item analysis, a Cronbach's Alpha coefficient of .708 (Nunnally, 1978) was obtained as a measure of the internal consistency of the PRM.

Procedures

Included in this section is a discussion of the procedures for: (a) selection of the research sites, (b) administration of the instruments during the research sessions, and (c) the statistical analysis of the data.

Site Selection

The cooperating school districts provided central sites to which teachers could come after school hours for the purposes of participating in the study. Site selection was based on the following criteria:

1. Availability of a site and at least one district staff member between the hours of 2:30 p.m. and 5:30 p.m.

2. Geographic convenience for the participants in the study.

3. Capacity to accommodate at least 30 teachers for the purposes of film viewing.

After the sites were selected, a time was reserved for the testing sessions.

Research Sessions

Each session began promptly at 3:30 p.m. Coffee and cookies were available for participants who arrived earlier. The study was introduced as involving preferences in science teaching (see Appendix E). The teachers were informed that they would be receiving free science materials from a publisher in an acknowledgment of their participation in the study. They were also told that a brief summary of the findings and conclusions would be sent to their

district's office for publication in the district bulletin after the study was completed.

All measures were collated separately and were held together with a large paper clip. At the start of each session the nature of the measuring instruments was described and instructions for completing the cover sheet were provided. Before each instrument was administered, the time allotment and instructions for answering the questions were given. Teachers were encouraged to ask questions only during the administration of the Teacher Background Information Instrument in order to make sure that they understood the intent of each question. Specific instructions accompanied each measure. The instruments were administered by the researcher and an assistant in the following order:

1. Teacher Background Information Instrument (Appendix B) was administered first. Twenty minutes were allowed for the completion of this instrument.

2. Science Teaching Situations (Appendix C). This measure consisted of eight attributional situations. It was administered in 20 minutes.

3. The Science Test of the National Teacher Examinations (ETS). The 30 items in this instrument were administered in 15 minutes, the time allowance normally provided by ETS for the completion of this instrument.

4. The Predicted Role Measure (Berger, 1972) (Appendix D). One hour was allowed for the administration of this instrument.

The investigator followed the procedures specified by Berger (1972, p. 50) with one exception. Berger states that he encouraged teachers to ask questions during the administration of the PRM. In the current study, after the sample item was completed and all questions raised by the subjects were addressed, no further questions were encouraged during the film showing. Any questions that were raised by the subjects were answered privately by the investigator while the research assistant continued to project the film. Not more than one or two teachers asked additional questions during each research session. This modification was implemented because the research sessions had to be completed with one and one-half hours.

Except for the Science Test (ETS), the teachers were required to respond to all items on every instrument. Teachers who could not complete all materials within the allotted time were allowed to remain after the session. No more than one or two teachers per session needed additional time to complete the questionnaires, and no teachers required more than an extra 5 or 10 minutes to finish all the items. The Science Test, a standardized, secure examination, was administered for 15 minutes as recommended by ETS. With few exceptions, the teachers did not complete all the items on the Science Test. During the administration of the three other instruments, the teachers were reminded frequently to complete every item. At the close of each session, the subjects were asked to check all test booklets for completion of all the items. The subjects were thanked for their participation.

S.H. ← Statistical Procedures for the Analysis of the Data

The data obtained were subjected to the following statistical analyses:

1. Means and standard deviations were obtained for each of the 28 variables.

2. t-test analyses were performed on mean scores of causal attributions for success and failure outcomes.

3. Pearson product-moment correlations were computed between scores for the 24 variables of the Attributional Model of Achievement Motivation (Weiner et al., 1978).

4. Stepwise multiple regression analyses of the 24 predictor variables and each of the four criterion variables of science teaching performance were performed.

Significance was set at the .05 level by the investigator because the variables in the study are difficult to define. A more stringent significance level might have penalized against the detection of significant trends. Nonetheless, the practical significance of the data will be determined by the magnitude of the statistical values.

The investigator had three primary concerns in applying the statistical design in the present study.

1. It was necessary to determine the nature of the teachers' causal attributions. The present research predicted no significant differences between teachers' causal attributions in success or

in failure situations. The t test for the difference between two independent means (Bruning & Kintz, 1977) was applied to each causal attribution for success and failure. The same statistical tests were applied to determine mean differences in causal attributions within the success and the failure situations.

2. A further aim of the present research was to determine whether the Attributional Model of Achievement Motivation (Weiner et al., 1978) provides a basis for explaining relationships between teacher antecedents and causal cognitions, and science teaching performance. Accordingly, Pearson product-moment correlations (Bruning & Kintz, 1977) were used to determine the relationships between the pairs of variables specified in the Weiner model.

3. The present research also sought to identify the independent variables that are significant predictors of each of the four performance variables. Stepwise regression analyses (Roscoe, 1975) were applied to the solution of this problem.

All statistical analyses were processed by programs of the statistical package for the Social Sciences (SPSS) (Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975).

Pilot Study

A pilot study was conducted in a community school district in Manhattan in December 1979. The purpose of the pilot study was fourfold: (a) to test the changes made in the measuring instruments as a result of the feasibility study, (b) to establish procedures involving the district office and school principals in the

recruitment of teachers, (c) to establish a method for contacting teachers and for administering the instruments under field conditions, and (d) to establish the reliability of the PRM as a measure of science teaching methods when applied to a group of respondents similar to the sample population of the present study.

The methods and procedures of the pilot study were found to be efficient for meeting these aims and were subsequently applied in the four school districts that participated in the main study. The school organization sheets provided by the principals in the pilot study indicated that 190 teachers of grades K-6 met the eligibility criteria: They taught in nonbilingual, self-contained classrooms, and science was not taught to their pupils by another teacher. All 190 eligible teachers were contacted at their schools by mail. Of these, 75 teachers returned the response card which both indicated their willingness to attend the research session and confirmed their eligibility to participate. Of these, 61 teachers participated in the pilot study. Thus, of those considered eligible, 32% finally constituted the pilot sample.

The 54 women and 7 men teachers who participated in the pilot study represented 12 out of 14 district schools and taught at all grade levels from kindergarten through 6. They had from 1 through 30 years of teaching experience ($\bar{X}$ = 12.4 years), and a mean age range between 36 and 40. A uniform method for administering the four instruments was established during the pilot study.

CHAPTER IV

FINDINGS

The purpose of this chapter is to report the results and to analyze the scores obtained in terms of elementary school teachers' (a) antecedents, (b) causal attributions, (c) causal effects, and (d) science teaching performance. The data obtained were subjected to the following statistical analyses:

1. Means and standard deviations were obtained for each of the 28 variables.

2. t-test analyses were performed on mean scores of causal attributions for success and failure outcomes.

3. Pearson product-moment correlations were computed beween scores for the 24 variables of the Attributional Model of Achievement Motivation (Weiner et al., 1978).

4. Stepwise multiple regression analyses of the 24 predictor variables and each of the 4 criterion variables of science teaching performance were performed.

The .05 level of significance was established by the investigator for all statistical tests performed in the present study.

The Nature of the Scores Used in the Data Analysis

1. Measures of antecedents. Ten antecedent variables were measured. These fell into two major categories: general background variables and science background variables.

a. General background variables. The following variables were measured by items in the Teacher Background Information Instrument.

(1) years of teaching experience--an open-ended response to Item 1.

(2) grade level--a choice of grade levels from kindergarten through grade 6 on Item 2. Respondents scored 0 for kindergarten through 6 for sixth grade.

(3) sex of teacher--a value of 0 was assigned to females and a value of 1 was assigned to males for Item 3.

(4) age of teacher--a choice of eight consecutive five-year ranges from 21-25 through 56 and over on Item 4. Respondents scored 1 for 21-25 through 8 for 56 and over.

These variables were entered into regression analyses as predictor variables.

b. Science background variables. Variables 1 through 5 were measured by items in the Teacher Background Information Instrument. Variable 6, knowledge of science content, was measured by the NTE Science Test (ETS).

(1) number of high school science courses--an open-ended response to Item 5.

(2) number of college science courses--an open-ended response to Item 5.

(3) number of graduate science courses--an open-ended response to Item 5.

(4) number of science teaching methods courses--total number of undergraduate and graduate courses and the total number of inservice workshops completed by respondents. An open-ended response to Item 7.

(5) perception of past science teaching as successful--measured by the respondents' scores on Item 9, a rating scale from 1 (extremely unsuccessful) through 8 (extremely successful). Therefore, scores ranged from 1 through 8.

(6) knowledge of science content--measured as the number of correct responses on the NTE Science Test. A range of 0 through 30 was possible.

All science background antecedents were entered into Pearson product-moment correlations and also served as predictor variables in regression analyses.

2. Measure of causal attributions. The Science Teaching Situations is an eight-item measure. Each item represents one situation. All items require the respondents to rate the probability of each of the four attributions as possible causes for the outcome (success or failure) of each situation on a four-point scale. For the four success situations combined and for the four failure situations combined, the possible range of total scores for each causal attribution was from 0 through 16. The range of total scores of causal attributions for combined success and combined failure outcomes was as follows:

Causal Attributions	Outcomes: Success	Outcomes: Failure
Ability	0 through 16	0 through 16
Effort	0 through 16	0 through 16
Task Difficulty	0 through 16	0 through 16
Luck	0 through 16	0 through 16

These scores were used in t tests, Pearson product-moment correlations, and stepwise regression analyses.

3. Measures of causal dimension. The scores for attributions were collapsed to yield scores for each of the four causal dimensions. The possible range of scores for each causal dimension in all four success situations combined and in all four failure situations combined was 0 through 32.

The degree of internality score was derived from the difference betwen mean internal dimension scores and mean external dimension scores. The degree of stability score was derived from the difference between mean stable dimension scores and mean unstable dimension scores.

The possible range for the derived scores of internality and stability in all four success situations combined and in all four failure situations combined was from -32 through 32. The range of scores of causal dimensions for success and failure outcomes was as follows:

Causal Dimensions	Outcomes: Success	Outcomes: Failure
Internal (ability + effort)	0 through 32	0 through 32
External (task difficulty + luck)	0 through 32	0 through 32
Internality (Internal - External)	-32 through 32	-32 through 32
Stable (ability + task difficulty)	0 through 32	0 through 32
Unstable (effort + luck scores)	0 through 32	0 through 32
Stability (Stable - Unstable)	-32 through 32	-32 through 32

Scores of causal dimensions were used in t tests, Pearson product-moment correlations, and stepwise regression analyses.

4. Measures of causal effects. Two categories of causal effects were measured : (a) expectancy shift and (b) affect. Causal effects were measured by scores on items 8, 15, and 16 in the Teacher Background Information Instrument.

a. Expectancy shift was measured by the respondents' scores on item 15 (past expectancy of science teaching outcome) subtracted from their scores on item 16 (future expectancy of science teaching outcome). The scales for both items 15 and 16 ranged from 1 through 8. The possible range of scores for expectancy shifts was from -7 (for less expectancy of success) through 7 (for greater expectancy of success).

b. Affect was measured by the respondents' scores on a scale of 1 (extremely unenjoyable) through 8 (extremely enjoyable) on item 8 of the Teacher Background Information Instrument. Therefore, possible scores ranged from 1 through 8.

Measures of causal effects were used in Pearson product-moment correlation analyses and in stepwise multiple regression analyses.

5. Measures of science teaching performance. Two indicators of science teaching performance were measured: science teaching method and time allocation for science teaching.

a. Science teaching method was measured by three scores on the Predicted Role Measure (PRM): the student emphasis, student-teacher cooperation, and teacher emphasis methods scores. Respondents expressed their degree of agreement or disagreement with six statements that described their reactions to each of nine science classroom situations. Each statement could be rated on a Likert-type scale of 0 through 4, with 2 as the neutral point. Each of the three methods was represented by a total of 18 statements, two for each of the nine situations. Therefore, the scores for each of the three teaching methods could range from 0 through 72.

b. A time allocation index for science teaching was determined using items 10 through 14 on the Teacher Background Information instrument. Item 10 determined if the respondent was or was not teaching science during the semester that the instrument was administered, and consisted of a yes-no choice. Respondents who chose no scored a 0 on Index of Time Allocation automatically. For respondents who chose yes, the Index of Time Allocation was computed from items 11, 12, and 13.

Item 11 was an open-ended measure of the number of weeks during the semester in which science was taught. Responses ranged from above 0 to above 20. Item 12 measured the number of times per week that science was taught. Six choices ranging from five days per

week through one day every other week were offered. Possible scores could range between 5 (for five days per week) through 0.5 (for one day every other week). A seventh choice, other, was not utilized by the respondents. Item 13 was an open-ended measure of the average length of each respondent's science lessons in minutes per week.

The Index of Time Allocation was computed by dividing the product of items 11, 12, and 13 (minutes per term) by a time factor which represented the amount of time for science learning per week suggested by the New York City and New York State Boards of Education. The time factor for grades kindergarten through 3 is 75 minutes per week; for grades 4 through 6 it is 150 minutes per week. There are approximately 20 weeks in an average school term. Thus, an index of time allocation score of 20 would indicate that a teacher's time allocation meets the expected levels. Index scores lower than 20 indicate that teachers are not meeting the expected levels of time allocation. Index scores higher than 20 indicate that teachers are exceeding the expected levels of time allocation.

Item 14 was a redundant measure of time allocation which required teachers to provide a time estimate of their science teaching in minutes per week. The response to item 14 should equal the product of the responses to items 12 and 13. Item 14 was entered into a Pearson product-moment correlation analysis as a test for internal consistency in estimating the reliability of the respondents' self-report of time allocation.

All measures of science teaching performance were entered into Pearson product-moment correlation analyses and also served as criterion variables in stepwise multiple regression analyses.

Table 3 presents the means and standard deviations for the variables used in the study.

Analyses of Mean Scores of Causal Attributions for Success and Failure Outcomes

Hypothesis 1: There are no significant differences between elementary school teachers' mean scores on the four causal attributions (ability, effort, task difficulty, and luck) as causes of their success or as causes of their failure when teaching science.

Table 4 presents the results of *t* tests performed on differences between the mean scores of each of the four causal attributions for success and failure outcomes separately. In success situations, the results indicate that the mean scores of the four causal attributions were all significantly different from each other (see Table 4). In success situations, the mean scores of each of the four causal attributions in order of magnitude were as follows: (Ability $\overline{X}$ = 10.795), Effort ($\overline{X}$ = 13.578), Task Difficulty ($\overline{X}$ = 9.025), and Luck ($\overline{X}$ = 7.702) (see Table 3). Thus, in success situations, effort attributions had the highest mean scores, and luck attributions had the lowest.

Table 3

Means and Standard Deviations of the Predictor and Criterion Variables for the Sample of Elementary School Teachers (N = 236)

Variable	Mean	SD	n
Antecedents			
Years of teaching experience	12.033	6.059	236
Grade level now teaching	3.093	1.619	236
Number of high school science courses	4.038	2.124	236
Number of college science courses	3.142	3.444	232
Number of graduate science courses	0.270	0.825	233
Number of science education courses	1.659	1.520	235
Perception of past science teaching as successful	5.348[a]	1.306	235
Score on standardized science test	20.470[b]	3.741	236
Causal Attributions			
Attributes success to ability	10.795[c]	2.692	235
Attributes success to effort	13.578[c]	2.033	235
Attributes success to ease of task	9.025[c]	2.314	235
Attributes success to luck	7.702[c]	2.976	235
Attributes failure to ability	5.459[c]	3.006	235
Attributes failure to effort	6.663[c]	3.986	235
Attributes failure to task difficulty	9.429[c]	2.771	235
Attributes failure to luck	7.880[c]	2.875	235
Causal Dimensions			
Internal success (ability + effort)	24.194[d]	4.723	235
External success (task difficulty + luck)	16.580[d]	4.924	235
Internality for success (Internal - External)	7.614[e]	5.685	235
Internal failure (ability + effort)	11.995[d]	6.617	235
External failure (task difficulty + luck)	17.161[d]	5.406	235
Internality for failure (Internal - External)	- 5.165[e]	7.438	235
Stable success (ability + task difficulty)	19.661[d]	4.483	235
Unstable success (effort + luck)	21.114[d]	4.502	235
Stability for success (Stable - Unstable)	- 1.453[e]	4.468	235
Stable failure (ability + task difficulty)	14.750[d]	4.916	235
Unstable failure (effort + luck)	14.406[d]	5.472	235
Stability for failure (Stable - Unstable)	.343[e]	4.186	235

Table 3 (continued)

Variable	Mean	SD	n
Causal Effects			
Enjoyment of science teaching	5.254[a]	1.646	236
Expected improvement in science teaching (shift)	0.451[f]	1.459	235
Criterion Variables			
Student emphasis teaching method	46.771[g]	8.993	236
Student-teacher cooperation method	48.402[g]	7.144	236
Teacher emphasis teaching method	36.961[g]	9.104	236
Index of time allocation for science teaching	12.053[h]	9.736	221

Note. Variations in n are caused by missing data.

[a]Possible range: 1 (low) through 8 (high)

[b]Possible raw score on NTE Science Test: 0 through 30

[c]Possible range: 0 (low) through 16 (high)

[d]Possible range: 0 (low) through 32 (high)

[e]Possible range: - 32 (low) through 32 (high)

[f]Possible range: -7 (greater failure) through 7 (greater success)

[g]Possible range: 0 through 72

[h]Score derived from the actual time teachers allocate per term divided by the time allocation per week suggested by New York City and State boards of education.

Table 4

t Tests for Differences Between Mean Scores of Teachers' Causal Attributions (*N* = 235)

Causal Attributions	Difference Between Means	Deviation of Difference	Error	*t* Value[a]
Success				
ability-effort	-2.783	2.830	0.308	-15.08*
ability-task	1.770	3.334	0.218	8.14*
ability-luck	3.093	4.101	0.268	11.56*
task-luck	1.323	3.036	0.198	6.68*
effort-task	4.553	3.050	0.199	22.89*
effort-luck	5.876	3.492	0.228	25.80*
Failure				
ability-effort	-1.204	3.122	0.204	- 5.91*
ability-task	-3.970	3.711	0.242	-16.40*
ability-luck	-2.421	3.835	0.250	- 9.68*
effort-luck	-1.217	4.770	0.311	- 3.91*
task-luck	1.548	2.803	0.183	8.47*
effort-task	-2.766	4.670	0.305	- 9.08*

[a] *df* = 234

*$p < .05$

For failure situations, results of the t tests indicate that the mean scores of the four causal attributions were all significantly different from each other (see Table 4). In failure situations the mean scores of each of the four causal attributions in order of magnitude were as follows: Task Difficulty ($\bar{X}$ = 9.429), Luck ($\bar{X}$ = 7.880), Effort ($\bar{X}$ = 6.663), and Ability ($\bar{X}$ = 5.459) (see Table 3). Thus, in failure situations task difficulty attributions had the highest mean scores and ability attributions had the lowest.

t tests were also performed to determine whether the mean scores of each of the four causal attributions were significantly different from each other for success and failure situations. Results indicate that for ability attributions the mean score for success situations is significantly higher than the mean score for failure situations (success $\bar{X}$ = 10.795; failure $\bar{X}$ = 5.459; t (234) = 18.99, $p < .05$) (see Tables 3 and 5). For effort attributions, the mean score for success situations is significantly higher than the mean score for failure situations (succes $\bar{X}$ = 13.578; failure $\bar{X}$ = 6.663; t (234) = 22.45, $p < .05$ (see Tables 3 and 5). However, results indicate that for task difficulty and luck attributions, the mean scores for success situations are not significantly different from the mean scores for failure situations (see Tables 3 and 5). Therefore, Hypothesis 1 was rejected.

Causal Attributions and Causal Dimensions

The four causal attributions are classified along two dimensions, internality (internal minus external) and stability (stable minus unstable). Effort and ability attributions are internal to

Table 5

t Tests for Differences in Mean Scores of Teachers' Attributions for Success and Failure Outcomes (*N* = 235)

Causal Attributions	Difference Between Means	Deviation of Difference	Error	*t* Value[a]
Ability (success-failure)	5.336	4.307	0.281	18.99*
Effort (success-failure)	6.914	4.721	0.308	22.45*
Task difficulty (success-failure)	-0.404	3.417	0.223	- 1.81
Luck (success-failure)	-0.178	3.373	0.220	- 0.81

[a] *df* = 234

*p < .05

the person on the internality dimension while luck and task difficulty are external. On the stability dimension, attributions which vary over time, for example, effort and luck, are perceived as unstable, while task difficulty and ability, which generally remain the same, are stable. Thus, effort is internal and unstable; ability is internal and stable; task difficulty is external and stable; and luck is external and unstable (Weiner, 1976).

t tests were performed to determine whether the mean scores of the causal dimensions were significantly different from each other for success and failure outcomes separately. Results indicate that in success situations, the mean scores for the internal attributions were significantly higher than the mean scores for the external attributions (internal success $\bar{X}$ = 24.194; external success $\bar{X}$ = 16.580; t (234) = 20.58, $p < .05$) (see Tables 3 and 6). In failure situations, the mean scores for internal attributions were significantly lower than the mean scores for external attributions (internal failure $\bar{X}$ = 11.995; external failure $\bar{X}$ = 17.161; t (234) = -10.67, $p < .05$) (see Tables 3 and 6). Results also indicate that in success situations the mean scores for the stable attributions were significantly lower than the mean scores for the unstable attributions (stable success $\bar{X}$ = 19.661; unstable success $\bar{X}$ = 21.114; t (234) = -5.00, $p < .05$) (see Tables 3 and 6). However, in failure situations, the mean scores for the stable attributions were not significantly different from the mean scores for the unstable attributions (stable failure $\bar{X}$ = 14.750; unstable failure $\bar{X}$ = 14.406; t (234) = 1.26, $p > .05$, n.s.) (see Tables 3 and 6).

Table 6

t Tests for Differences Between Mean Scores of Teachers' Causal Dimensions (*N* = 235)

Causal Dimensions	Difference Between Means	Deviation of Differences	Error	*t* Value[a]
Success				
internal-external	7.614	5.685	.370	20.58*
stable-unstable	-1.453	4.468	.291	- 5.00*
Failure				
internal-external	-5.165	7.438	.484	-10.67*
stable-unstable	.343	4.186	.272	1.26

[a] *df* = 234

*p < .05

t tests were also performed to determine if the mean scores of each of the four causal dimensions were significantly different from each other for success and failure situations. Results indicate that for internal attributions the mean score for success situations is significantly higher than the mean score for failure situations (success $\bar{X}$ = 24.194; failure $\bar{X}$ = 11.995; *t* (234) = 23.81, *p* < .05) (see Tables 3 and 7). For external attributions, the mean score for success situations is not significantly different from the mean score for failure situations (success $\bar{X}$ = 16.580; failure $\bar{X}$ = 17.161; *t* (234) = 1.62, *p* > .05, n.s.) (see Table 3 and 7). Results also indicate that for stable attributions the mean score for success situations is significantly higher than the mean score

Table 7

t Tests for Differences in Mean Scores of Teachers' Causal Dimensions for Success and Failure
(*N* = 235)

Causal Dimensions	Difference Between Means[a]	Deviation of Difference	Error	*t* Value[b]
Internal (success-failure)	12.119	7.872	.512	23.81*
External (success-failure)	- .580	5.518	.359	- 1.62
Stable (success-failure)	4.911	5.482	.357	13.76*
Unstable (success-failure)	6.708	5.435	.354	18.96*
Internality (success-failure)	12.779	10.055	.655	19.53*
Stability (success-failure)	- 1.796	5.953	.388	- 4.64*

[a]Mean score for success minus mean score for failure

[b]*df* = 234

*$p < .05$

for failure situations (success $\bar{X}$ = 19.661; failure $\bar{X}$ = 14.750; t (234) = 13.76, $p < .05$) (see Tables 3 and 7). For unstable attributions, the mean score for success attributions was also significantly higher than the mean score for failure attributions (success $\bar{X}$ = 21.114; failure $\bar{X}$ = 14.406; t (234) = 18.96, $p < .05$) (see Tables 3 and 7). In addition, t tests were also performed to determine if the mean scores for internality and stability were significantly different from each other for success and failure situations. For internality, the mean score for success was significntly higher than the mean score for failure (success $\bar{X}$ = 7.614; failure $\bar{X}$ = -5.165; t (234) = 19.53, $p < .05$) (see Tables 3 and 7). For stability, the mean score for success was significntly lower than the mean score for failure (success $\bar{X}$ = -1.453; failure $\bar{X}$ = .343; t (234) = -4.64, $p < .05$) (see Tables 3 and 7).

Analyses of the Relationships Between Antecedents and Causal Attributions

Hypothesis 2a: There is no significant relationship between the total number of science content courses completed by elementary school teachers in high school, college, and graduate school, and their causal attributions for success or failure when teaching science as measured by Science Teaching Situations, a measure of causal attributions.

In success situations, the number of high school science content courses completed was negatively and significantly related to teachers' attributions to ability (r = -.108) and effort (r =

-.219) (see Table 8). There were no significant relationships between the number of high school science content courses completed by teachers and their attributions of success to task difficulty and luck (see Table 8). In failure situations, there were no significant relationships between the number of high school science content courses completed and any of the four causal attributions.

In success situations, the number of college science content courses completed was positively and significantly related to teachers' attributions to ability (r = .129). In success situations, there was no significant relationship between the number of college science content courses completed by teachers in the sample and their attributions of success to effort, task difficulty, and luck (see Table 8). In future situations, there were no significant relationships between the number of college science content courses completed and any of the four causal attributions.

The number of graduate level science content courses completed was not significantly related to any of the four causal attributions in both the success and the failure situations (see Table 8).

Hypothesis 2b: There is no significant relationship between the total number of science teaching methods courses completed by elementary school teachers and their causal attributions for success or failure when teaching science as measured by Science Teaching Situations, a measure of causal attributions.

There was no significant relationship between the number of college science education courses completed by the teachers in the

Table 8

Intercorrelations Among Predictor Variables (1-24) and Science Teaching Performance Variables (25-28)
(N = 236)

	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Teaching experience	-.077	.024	.618*	-.163*	.049	.056	.172*	.080	.026	.105	.026	.096	.030
2. Grade level		.358*	-.233*	.180*	-.092	.010	-.010	.059	.106	-.062	-.148*	-.204*	-.135*
3. Sex			-.156*	.231*	.098	.027	-.112*	-.004	.143*	.066	-.148*	-.125*	-.125*
4. Age				-.338*	.043	.009	.105	.070	-.126*	.096	.209*	.069	.030
5. High school science courses					-.004	.053	.063	.004	.177*	-.108*	-.219*	.009	-.007
6. College science courses						.393*	.100	-.053	.019	.129*	.048	-.024	.046
7. Graduate science courses							.187*	.007	-.036	.049	.042	.024	.061
8. Science education courses								.200*	-.033	.059	.083	-.006	-.067
9. Past science teaching successful									-.016	.337*	.180*	-.039	-.037
10. Standardized science test score										.069	-.168*	.028	.088
11. Attributes success to ability											.308*	.119*	-.044
12. Attributes success to effort												.020	.066
13. Attributes success to ease of task													.362*
14. Attributes success to luck													
15. Attributes failure to ability													
16. Attributes failure to effort													
17. Attributes failure to task difficulty													
18. Attributes failure to luck													
19. Internality for success													
20. Stability for success													
21. Internality for failure													
22. Stability for failure													
23. Enjoyment of science teaching													
24. Expected improvement in science teaching													
25. Student emphasis teaching method													
26. Student-teacher cooperation method													
27. Teacher emphasis teaching method													
28. Index of time allocation													

Table 8 (continued)

		15	16	17	18	19	20	21	22	23	24	25	26	27	28
1.	Teaching experience	.061	.031	-.082	-.158*	-.010	.083	.138*	.066	-.030	.153	.002	-.017	-.045	.091
2.	Grade level	.018	-.008	.112*	.014	.064	.015	-.041	.085	-.037	.000	-.062	.020	.080	-.046
3.	Sex	-.041	-.040	-.041	-.087	.033	.045	.009	.040	-.063	-.038	.018	.052	-.039	-.045
4.	Age	-.012	-.106	-.085	-.138*	.065	-.018	.027	.129*	-.048	.046	.088	-.086	-.086	.004
5.	High school science courses	-.050	.068	-.035	-.096	-.123*	.044	.063	-.060	.071	-.087	-.045	-.046	.037	.012
6.	Number of college science courses	-.023	-.000	.038	.063	.067	.012	-.050	-.035	.080	-.037	-.024	.023	-.035	.068
7.	Graduate science courses	.030	-.007	-.012	.051	-.008	-.016	-.004	-.014	.029	-.107*	-.124*	.029	-.025	.001
8.	Science education courses	.004	-.022	-.025	-.075	.086	.041	.032	.059	.185*	-.109*	.087	.115*	-.011	.178*
9.	Past science teaching successful	-.255*	-.219*	.086	-.042	.249*	.126*	-.231*	.111*	.453*	-.039	.119*	-.060	-.041	.100
10.	Standardized science test score	-.039	.150*	.110*	.046	-.072	.071	-.000	-.128*	.127*	-.052	-.094	-.074	-.102	.058
11.	Attributes success to ability	-.139*	-.125*	.126*	.047	.559*	.552*	.189*	.070	.275*	.020	.072	.069	.110*	.158*
12.	Attributes success to effort	.041	-.139*	.134*	.077	.461*	-.302*	-.138*	.198*	.042	.027	.049	.032	-.002	.089
13.	Attributes success to ease of task	.193*	.112*	.106	.119*	-.534*	.338*	.052	.020	.006	.054	.115*	-.052	.102	.032
14.	Attributes success to luck	.214*	.231*	.241*	.335*	-.669*	-.534*	-.008	-.137*	-.051	-.013	.020	-.003	.052	-.021
15.	Attributes success to ability		.633*	.176*	.150*	-.242*	-.145*	.619*	.128*	-.153*	.156*	.073	.107*	-.014	-.079
16.	Attributes failure to effort			.079	.061	-.227*	-.108*	.737*	-.485*	-.048	.017	-.029	.059	-.047	-.161*
17.	Attributes failure to task difficulty				.507*	-.061	-.090	-.454*	.363*	.037	-.027	.050	-.019	.103	.037
18.	Attributes failure to luck					-.174*	-.168*	-.481*	-.300*	-.040	.116*	-.013	.093	.094	.004
19.	Internality for success						.293*	.293*	-.159*	.170*	.006	-.002	.067	-.018	.106
20.	Stability for success							-.017	.054	.183*	.037	.066	.002	.085	.086
21.	Internality for failure								-.227*	-.086	.127*	-.001	.046	-.105	-.134*
22.	Stability for failure									-.011	.159*	.123*	-.056	.039	.119*
23.	Enjoyment of science teaching										-.173*	.049	.047	.058	.137*
24.	Expected improvement in science teaching											.148*	-.020	.076	.087
25.	Student emphasis teaching method												.350*	.131*	.138*
26.	Student teacher cooperation method													.307*	.040
27.	Teacher emphasis teaching method														.032
28.	Index of time allocation														

*$p < .05$

sample and any of the four causal attributions for both success and failure situations (see Table 8).

Hypothesis 2c: There is no significant relationship between elementary school teachers' knowledge of science content as measured by their scores on the Science Test of the National Teachers Examinations (ETS) and their causal attributions for success or failure when teaching science as measured by Science Teaching Situations, a measure of causal attributions.

In the success condition, there was a significant and negative relationship between scores on the Science Test and effort attributions (r = -.168). No significant relationships were found between Science Test scores and any of the other causal attributions (ability, task difficulty, and luck) in the success condition (see Table 8).

In the failure condition, significant and positive relationships were found between scores on the Science Test and attributions to effort (r = .150) and task difficulty (r = .110). The relationships between Science Test scores and the other two causal attributions (ability and luck) were not significant in the failure condition (see Table 8). Thus, scores on the measure of science knowledge were not significantly related to ability and luck attributions in either the success or failure conditions.

Hypothesis 2d: There is no significant relationship between elementary school teachers' perceptions of the degree to which they have been successful or unsuccessful in their past science teaching and their causal attributions for success or failure when teaching

science as measured by Science Teaching Situations, a measure of causal attributions.

In the success condition, teachers' perceptions of the degree of their past success when teaching science was positively and significantly related to their attributions to ability (r = .337) and effort (r = .180). There were no significant relationships between teachers' perceptions of the degree of their past success when teaching science and the other causal attributions (task ease and luck) in the success condition (see Table 8).

In the failure condition, teachers' perceptions of the degree of their past success when teaching science was negatively and significantly related to their attributions to ability (r = -.255) and effort (r = -.219). Perceptions of the degree of their past success in teaching science were not significantly related to teachers' luck or task difficulty attributions for failure situations (see Table 8).

Analyses of the Relationships Between Antecedents and Causal Effects

Hypothesis 3a: There is no significant relationship between elementary school teachers' perceptions of the degree to which they have been successful or unsuccessful in their past science teaching, and the degree of their expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their science teaching to be successful or unsuccessful in the future.

There was no significant relationship between teachers' perceptions of the degree to which they have been successful in their past science teaching and the degree of their expectancy shifts (see Table 8).

Hypothesis 3b: There is no significant relationship between elementary school teachers' knowledge of science content as measured by their score on the Science Test of the National Teachers Examination (ETS) and the nature of their expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their science teaching to be successful or unsuccessful in the future.

There was no significant relationship between scores on the NTE Science Test (ETS) and the degree of teachers' expectancy shifts (see Table 8).

Hypothesis 3c: There is no significant relationship between the total number of science content courses completed by elementary school teachers in high school, college, and graduate school, and the degree of their expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their science teaching to be successful or unsuccessful in the future.

There was no significant relationship between the number of science courses teachers had completed in high school and college

and the degree of their expectancy shifts. However, there was a negative and significant relationship between the number of graduate science courses completed by teachers and the degree of their expectancy shifts (r = -.107) (see Table 8).

Hypothesis 3d: There is no significant relationship between the total number of science teaching methods courses completed by elementary school teachers and the degree of their expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their science teaching to be successful or unsuccessful in the future.

There was a negative and significant relationship between the number of science teaching methods courses completed by the sample population and the degree of their expectancy shifts (r = -.109) (see Table 8).

Hypothesis 3e: There is no significant relationship between the total number of science content courses completed by elementary school teachers in high school, college, and graduate school, and the degree to which they enjoy teaching science.

The number of science content courses completed by the sample population in high school, college, or graduate school was not significantly related to their degree of enjoyment of science teaching (see Table 8).

Hypothesis 3f: There is no significant relationship between the total number of science teaching methods courses completed by

elementary school teachers and the degree to which they enjoy teaching science.

There was a significant and positive relationship between the number of science teaching methods courses completed by teachers in the sample and the degree to which they enjoyed teaching science (r = .185) (see Table 8).

Hypothesis 3g: There is no significant relationship between elementary school teachers' knowledge of science content as measured by their scores on the Science Test of the National Teachers Examination (ETS) and the degree to which they enjoy teaching science.

There was a positive and significant relationship between teachers' knowledge of science content as measured by the Science Test and the degree of their enjoyment of science teaching (r = .127) (see Table 8).

Hypothesis 3h: There is no significant relationship between elementary school teachers' perceptions of the degree to which they have been successful and unsuccessful in their past science teaching, and the degree to which they enjoy teaching science.

There was a positive and significant relationship between teachers' perceptions of the degree to which they have been successful in their past science teaching and the degree to which they enjoy teaching science (r = .453) (see Table 8).

Analyses of the Relationships Between Antecedents and Science Teaching Performance

Hypothesis 4a: There is no significant relationship between the total number of science content courses completed by elementary school teachers in high school, college, and graduate school, and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

There was a low, negative, and significant relationship between the total number of science content courses completed by the teachers in graduate school and their student emphasis teaching scores ($r = -.124$) (see Table 8). There were no significant relationships between the teachers' student-teacher cooperation scores and teacher emphasis scores and their total number of graduate science courses. There was no significant relationship between any of teachers' scores on the PRM and their number of science content courses completed in high school and college (see Table 8).

Hypothesis 4b: There is no significant relationship between the total number of science teaching methods courses completed by elementary school teachers and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

There was a positive and significant relationship between the total number of science teaching methods courses completed by

teachers in the sample and their student-teacher cooperation scores (r = .115) (see Table 8). However, there was no significant relationship between teacher emphasis scores or student emphasis scores and the total number of science teaching methods courses completed by teachers (see Table 8).

Hypothesis 4c: There is no significant relationship between elementary school teachers' knowledge of science content as measured by their scores on the Science Test of the National Teachers Examination (ETS) and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

There was no significant relationship between teachers' knowledge of science content and their choice of science teaching methods (see Table 8).

Hypothesis 4d: There is no significant relationship between the total number of science content courses completed by elementary school teachers in high school, college, and graduate school, and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

There were no significant relationships between the number of science content courses completed by the sample population in high school, college, or graduate school and their index of time allocation for teaching science (see Table 8).

Hypothesis 4e: There is no significant relationship between the total number of science teaching methods courses completed by elementary school teachers and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

There was a positive and significant relationship between the number of science teaching methods courses completed by the sample population and their index of time allocation (r = .178) (see Table 8).

Hypothesis 4f: There is no significant relationship between elementary school teachers' knowledge of science content as measured by their score on the Science Test of the National Teachers Examination (ETS) and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

There was no significant relationship between teachers' scores on the NTE Science Test and their index of time allocation (see Table 8).

Hypothesis 4g: There is no significant relationship between elementary school teachers' perceptions of the degree to which they have been successful or unsuccessful in their past science teaching and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

There was a significant and positive relationship between teachers' perceptions of the degree to which they have been successful in their past science teaching and their student emphasis scores on the PRM (r =.119) (see Table 8). However, there were no significant relationships betwen teachers' perceptions of their past science teaching and their student-teacher cooperation or their teacher emphasis scores on the PRM (see Table 8).

Hypothesis 4h: There is no significant relationship between elementary school teachers' perceptions of the degree to which they have been successful or unsuccessful in their past science teaching and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

There was no significant relationship between teachers' perceptions of the degree to which they have been successful at past science teaching and their index of time allocation (see Table 8).

Analyses of the Relationships Between Causal Dimensions and Causal Effects

Hypothesis 5a: There is no significant relationship between the internality of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions, and the degree to which they enjoy teaching science.

In success situations, there was a significant and positive relationship between the internality dimension of elementary school techers' causal attributions and the degree to which they enjoy teaching science (r = .170) (see Table 8).

There was no significant relationship in the failure condition between the internality dimension of the causal attributions of elementary school teachers and the degree to which they enjoy teaching science (see Table 8).

Hypothesis 5b: There is no significant relationship between the stability of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions, and the degree to which they enjoy teaching science.

There was a positive and significant relationship in the success condition, between the stability dimension of the causal attributions of elementary school teachers and the degree to which they enjoy teaching science (r = .183) (see Table 8).

There was no significant relationship in the failure situation between the stability dimension of elementary school teachers' causal attributions and the degree to which they enjoy teaching science.

Hypothesis 5c: There is no significant relationship between the internality of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions, and their expectancy shifts (typical or atypical), as measured by the degree to which teachers' past

expectancy for the outcome of their science teaching differs from the degree to which they expect their future science teaching to be successful or unsuccessful.

In the success condition there was no significant relationship between the internality dimension of the causal attributions of elementary school teachers and their expectancy shifts (see Table 8).

In the failure condition, there was a positive and significant relationship between the internality dimension of the causal attributions of the sample population and their expectancy shifts (r = .127) (see Table 8).

Hypothesis 5d: There is no significant relationship between the stability of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions, and their expectancy shifts (typical or atypical), as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their future science teaching to be successful or unsuccessful.

There was no significant relationship in the success condition between the stability dimension of teachers' causal attributions and their expectancy shifts (see Table 8).

In the failure condition, there was a positive and significant relationship between the stability dimension of the causal attributions of the sample population and their expectancy shifts (r = .159) (see Table 8).

Analyses of the Relationships Between Causal Dimensions and Science Teaching Performance

Hypothesis 6a: There is no significant relationship between the internality of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of their causal attributions, and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, and teacher emphasis method.

For success and failure conditions, there were no significant relationships between the internality dimension of the teachers' causal attributions and their student emphasis, student-teacher cooperation, and teacher emphasis method scores (see Table 8).

Hypothesis 6b: There is no significant relationship between the internality of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions, and their persistence of science teaching performance, as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

In the success condition, there was no significant relationship between the internality dimension of teachers' causal attributions and their index of time allocation (see Table 8).

In the failure condition, there was a negative and significnt relationship between the internality dimension of teachers' causal

attributions and their index of time allocation (r = -.134) (see Table 8).

Hypothesis 6c: There is no significant relationship between the stability of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, and teacher emphasis method.

For the success condition, there was no significant relationship between the stability dimension of elementary school teachers' causal attributions and any of their scores on the PRM (see Table 8). For the failure condition, there was a positive and significant relationship between the stability dimension of elementary school teachers' causal attributions and their student emphasis scores (r = .123) (see Table 8).

However, for the failure condition, there was no significant relationship between the stability dimension of elementary school teachers' causal attributions and their student-teacher cooperation and teacher emphasis methods scores (see Table 8).

Hypothesis 6d: There is no significant relationship between the stability of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions, and their persistence of science teaching performance, as measured by their index of time allocation:

their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

In the success condition, there was no significant relationship between the stability dimension of elementary school teachers' causal attributions and their index of time allocation (see Table 8).

In the failure condition, there was a positive and significant relationship betwen the stability of elementary school teachers' causal attributions and their index of time allocation (r = .119) (see Table 8).

Analyses of the Relationships Between Causal Effects and Science Teaching Performance

Hypothesis 7a: There is no significant relationship between the degree of elementary school teachers' expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their future science teaching to be successful or unsuccessful, and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

There was a positive and significant relationship between the degree of elementary school teachers' expectancy shifts and their student emphasis teaching scores (r = .148) (see Table 8). However, there were no significnt relationships between the degree of elementary school teachers' expectancy shifts and their student-

teacher cooperation or teacher emphasis method scores (see Table 8).

Hypothesis 7b: There is no significant relationship between the degree of elementary school teachers' expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their future science teaching to be successful or unsuccessful, and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

There was no significant relationship between elementary school teacher' expectancy shifts and their index of time allocation (see Table 8).

Hypothesis 7c: There is no significant relationship between the degree to which elementary school teachers enjoy teaching science and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

There was no significant relationship between teachers' enjoyment of science teaching and their choice of science teaching method as measured by the PRM: student emphasis, student-teacher cooperation, and teacher emphasis methods (see Table 8).

Hypothesis 7d: There is no significant relationship between the degree to which elementary school teachers enjoy teaching science

and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

There was a positive and significant relationship between teachers' enjoyment of science teaching and their persistence in teaching science as measured by their index of time allocation (r = .137) (see Table 8).

Stepwise Multiple Regression Analyses of the Predictor and the Performance Variables of the Attributional Model of Achievement Motivation (Weiner et al., 1978)

Hypothesis 8a: The 24 selected predictor variables are not significant predictors of elementary school teachers' persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required.

In order to determine the most efficient predictors of time allocations from among the variables of the attributional model, a stepwise regression analysis was applied. The values of the regression coefficients (b), errors of estimate (standard error of $S_{Y'}$), multiple correlations (R), coefficients of determination (R^2), changes in the coefficients of determination (R^2 change), the constant, and the F values were determined in order to derive the regression equation.

The results of the stepwise regression analysis of the 24 predictor variables and Index of Time Allocation as the criterion variables are presented in Table 9. It was found that variable 8 (number of science teaching methods courses) was the most significant predictor of the index of time allocation.

Table 10 presents the results of subsequent F tests for the significance of the variance increments by additional predictors. The data indicate that variable 16 (attributes failure to lack of effort) negatively, and variable 11 (attributes success to ability) resulted in further significant contributions to the predictions of time allocation in that order. The process of selection was terminated beyond the third variable since the addition of further variables did not produce significant F values. Therefore, the null hypothesis that the 24 predictor variables are not significant predictors of elementary school teachers' persistence of science teaching performance as measured by their index of time allocation, was rejected.

A multiple correlation of .271 and standard error of .423 were obtained. The final coefficient of multiple determination indicates that taken together, the first three variables in Table 9 account for 7.3% of the criterion variance. The optimum combination of variables (.05 level) results in the following multiple regression equation:

$$Y' = 1.072X_8 - 0.345X_{16} + 0.473X_{11} + 7.467$$

Table 9

Stepwise Regression Analysis of the Attributional Predictor Variables of Index of Time Allocation (N = 221)

Variable[a]	b	Constant	$S_{Y'}$	R	R^2	F
8	1.142	10.156	.429	.178	.031	7.071*
8	1.120	12.760	.425	.238	.056	6.428*
16	-0.385					
8	1.072	7.467	.423	.271	.073	5.628*
16	-0.345					
11	0.473					
8	1.148	7.176	.424	.291	.084	4.906*
16	-0.349					
11	0.461					
24	0.713					

[a]Numbers in this column refer to the following variables:
Variable 8 = Science education courses
Variable 16 = Attributes failure to effort
Variable 11 = Attributes success to ability
Variable 24 = Expects improvement in science teaching

*$p < .05$

Table 10

F Test for the Significance of Addition of Variance Increments by the Predictors of Index of Time Allocation

Variable[a]	R^2	*F* Value of R^2 Increment
8	.031	--
8 16	.056	5.77*
8 16 11	.073	3.98*
8 16 11 24	.084	2.59

$F_{.05}$ (1, 227) = 3.89

[a]Numbers in this column refer to the following variables:
Variable 8 = Science education courses
Variable 16 = Attributes failure to effort
Variable 11 = Attributes success to ability
Variable 24 = Expects improvement in science teaching

*$p < .05$

The data in Table 10 show, therefore, that 3 of the 24 variables were the most efficient predictors of the index of time allocation. These varibles are: Number of Science Teaching Methods Courses (variable 8), Attribution of Failure to Lack of Effort, negatively (variable 16), and Attribution of Success to Ability (variable 11).

Hypothesis 8b: The 24 selected predictor variables are not significant predictors of elementary school teachers' choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, and teacher emphasis methods.

In order to determine the most efficient predictors of student emphasis, student-teacher cooperation, and teacher emphasis of science teaching methods from among the 24 selected predictor variables, three separate stepwise regression analyses were computed. The values of the regression coefficients (b), errors of estimate (standard error of $S_{Y'}$), multiple correlation (R), coefficients of multiple determination (R^2), the constant, and the F values were determined in order to derive the regression equation for each criterion variable.

Student Emphasis Method

The results of the regression analysis of the 24 selected predictor variables of the student emphasis method are presented in Table 11. It was found that the first significant predictor was variable 24 (expectancy shift).

Table 11

Stepwise Regression Analysis of the Attributional Predictor Variables of the Student Emphasis Method (N = 229)

Variable[a]	b	Constant	$S_{Y'}$	R	R^2	F
24	0.917	46.357	.402	.148	.022	5.187*
24	0.947	41.716	.400	.194	.037	4.492*
9	0.864					

[a]Numbers in this column refer to the following variables:
Variable 24 = Expects improvement in science teaching
Variable 9 = Perceives past science teaching as successful.

*$p < .05$

Subsequent F tests for the significance of the variance increments by additional predictors indicated that no additional variables contributed significantly to the prediction of student emphasis teaching (see Table 12). The process of selection was terminated beyond the first F test since the addition of further variables did not significantly increase the powers of prediction. Therefore, the null hypothesis that the 24 selected predictor variables are not significant predictors of the student emphasis method as measured by the PRM was rejected.

A multiple correlation of .148 and a standard error of .402 were obtained. The final coefficient of multiple determination indicates that one variable in Table 11 accounts for 2.2% of the criterion variance. The following multiple regression equation yields the best prediction:

$$Y' = 0.917X_{24} + 46.375$$

Table 12

F Test for the Significance of Addition of Variance Increments by the Predictors of the Student Emphasis Teaching Method (N = 229)

Variable[a]	R^2	F Value of R^2 Increment
24	.022	--
24 9	.037	3.52

$F_{.05}$ (1, 227) = 3.89

[a]Numbers in this column refer to the following variables:
Variable 24 = Expects improvement in science teaching
Variable 9 = Perceives past science teaching as successful

The data in Table 12 show, therefore, that only 1 of the 24 variables was an efficient predictor of the student emphasis teaching method. This variable is expectancy shift (variable 24).

Student-Teacher Cooperation Method

A stepwise regression analysis of the 24 selected predictor variables of the student-teacher cooperation method yielded variable 8 (number of science teaching methods courses completed) as the first predictor. However, the F value of 3.091 for variable 8 was not significant. Therefore, no regression equation can be derived for the data in Table 13. Thus, the null hypothesis that the 24 selected predictor variables are not significant predictors of the student-teacher cooperation method as measured by the PRM was retained.

Table 13

Stepwise Regression Analysis of the Attributional Predictor Variables and the Student-Teacher Cooperation Method (N = 229)

Variable	b	Constant	S_Y,	R	R^2	F
8[a]	0.524	47.502	.308	.115	.013	3.091

$F_{.05}$ (1, 227) = 3.89

[a]Variable 8 = Science education courses

Teacher Emphasis Method

A stepwise regression of the 24 selected predictor variables of the teacher emphasis method yielded variable 11 (attribution of success to ability) as the first predictor. However, the F value of 2.811 for variable 11 was not significant. Therefore, no regression equation can be derived for the data in Table 14. Thus, the null hypothesis that the 24 selected predictor variables are not significant predictors of the teacher emphasis method as measured by the PRM was retained.

Table 14

Stepwise Regression Analysis of the Attributional Predictor Variables of the Teacher Emphasis Method (N = 229)

Variable	b	Constant	S_Y,	R	R^2	R^2 Change	F
11[a]	.372	32.941	.222	.110	.012	.012	2.811

$F_{.05}$ (1, 227) = 3.89

[a]Variable 11 = Attributes success to ability

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS FOR FURTHER RESEARCH

This chapter presents a general summary of the purpose, materials, procedures, and findings of the study. Conclusions derived from the findings are presented in the second section. The chapter concludes with implications of the findings. Recommendations for further research are suggested in this final section.

Summary

Purpose of the Study

The present study applied the Attributional Model of Achievement Motivation (Weiner et al., 1978) to an analysis of science teaching performance. The purpose was to determine the relationships between elementary school teachers' antecedent factors and causal perceptions, and their behaviors as science teachers. In addition, an attempt was made to identify those teacher antecedents and causal perceptions which are the best predictors of science teaching performance. In this investigation two indicators of science teaching performance served as dependent variables, namely: (a) choice of teaching method: student emphasis, student-teacher cooperation, and teacher emphasis methods as measured by the Predictive Role Measure (Berger, 1972), and (b) persistence in teaching science, an index computed from the amount of classroom time teachers allocate to science teaching per week and the amount of time the Boards of

Education of New York City and New York State expect them to allocate per week.

Hypotheses of the Study

The present investigation tested the following null hypotheses.

Causal attributions.

1. There are no significant differences among elementary teachers' mean rating scores of four attributions (ability, effort, task difficulty, and luck) as causes of their success or as causes of their failure when teaching science as measured by Science Teaching Situations, a measure of causal attributions.

Antecedents and causal attributions.

2a. There is no significant relationship between the total number of science content courses completed by elementary school teachers in high school, college, and graduate school, and their causal attributions for success or failure when teaching science as measured by Science Teaching Situations, a measure of causal attributions.

2b. There is no significant relationship between the total number of science teaching methods courses completed by elementary school teachers and their causal attributions for success or failure when teaching science as measured by Science Teaching Situations, a measure of causal attributions.

2c. There is no significant relationship between elementary school teachers' knowledge of science content as measured by their scores on the Science Test of the National Teachers Examinations

(ETS) and their causal attributions for success or failure when teaching science as measured by Science Teaching Situations, a measure of causal attributions.

2d. There is no significant relationship between elementary school teachers' perceptions of the degree to which they have been successful or unsuccessful in their past science teaching and their causal attributions for success or failure when teaching science as measured by Science Teaching Situations, a measure of causal attributions.

Antecedents and causal effects.

3a. There is no significant relationship between elementary school teachers' perceptions of the degree to which they have been successful or unsuccessful in their past science teaching, and the degree of their expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their science teaching to be successful or unsuccessful in the future.

3b. There is no significant relationship between elementary school teachers' knowledge of science content as measured by their score on the Science Test of the National Teachers Examination (ETS) and the nature of their expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their science teaching to be succesful or unsuccessful in the future.

3c. There is no significant relationship between the total number of science content courses completed by elementary school teachers in high school, college, and graduate school, and the degree of their expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their science teaching to be successful or unsuccessful in the future.

3d. There is no significant relationship between the total number of science teaching methods courses completed by elementary school teachers and the degree of their expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their science teaching to be successful or unsuccessful in the future.

3e. There is no significant relationship between the total number of science content courses completed by elementary school teachers in high school, college, and graduate school, and the degree to which they enjoy teaching science.

3f. There is no significant relationship between the total number of science teaching methods courses completed by elementary school teachers and the degree to which they enjoy teaching science.

3g. There is no significant relationship between elementary school teachers' knowledge of science content as measured by their score on the Science Test of the National Teachers Examination (ETS) and the degree to which they enjoy teaching science.

3h. There is no significant relationship between elementary school teachers' perceptions of the degree to which they have been successful or unsuccessful in their past science teaching, and the degree to which they enjoy teaching science.

Antecedents and science teaching performance.

4a. There is no significant relationship between the total number of science content courses completed by elementary school teachers in high school, college, and graduate school, and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

4b. There is no significant relationship between the total number of science teaching methods courses completed by elementary school teachers and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

4c. There is no significant relationship between elementary school teachers' knowledge of science content as measured by their scores on the Science Test of the National Teachers Examination (ETS) and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

4d. There is no significant relationship between the total number of science content courses completed by elementary school teachers in high school, college, and graduate school, and their

persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

4e. There is no significant relationship between the total number of science teaching methods courses completed by elementary school teachers and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

4f. There is no significant relationship between elementary school teachers' knowledge of science content as measured by their score on the Science Test of the National Teachers Examination (ETS) and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

4g. There is no significant relationship between elementary school teachers' perceptions of the degree to which they have been successful or unsuccessful in their past science teaching and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

4h. There is no significant relationship between elementary school teachers' perceptions of the degree to which they have been

successful or unsuccessful in their past science teaching and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

Causal dimensions and causal effects.

5a. There is no significant relationship between the internality of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions, and the degree to which they enjoy teaching science.

5b. There is no significant relationship between the stability of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions, and the degree to which they enjoy teaching science.

5c. There is no significant relationship between the internality of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions, and their expectancy shifts (typical or atypical), as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their future science teaching to be successful or unsuccessful.

5d. There is no significant relationship between the stability of the causal attributions of elementary school teachers as measured

by their scores on Science Teaching Situations, a measure of causal attributions, and their expectancy shifts (typical or atypical), as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their future science teaching to be successful or unsuccessful.

Causal dimensions and science teaching performance.

6a. There is no significant relationship between the internality of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of their causal attributions, and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, and teacher emphasis method.

6b. There is no significant relationship between the internality of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions, and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

6c. There is no significant relationship between the stability of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions, and their choice of method for teaching science as

measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, and teacher emphasis method.

6d. There is no significant relationship between the stability of the causal attributions of elementary school teachers as measured by their scores on Science Teaching Situations, a measure of causal attributions, and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

Causal effects and science teaching performance.

7a. There is no significant relationship between the degree of elementary school teachers' expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their future science teaching to be successful or unsuccessful, and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

7b. There is no significant relationship between the degree of elementary school teachers' expectancy shifts (typical or atypical) as measured by the degree to which teachers' past expectancy for the outcome of their science teaching differs from the degree to which they expect their future science teaching to be successful or unsuccessful, and their persistence of science teaching performance as measured by their index of time allocation: their estimated

actual science teaching time allocation per term, divided by the amount of time officially required per week.

7c. There is no significant relationship between the degree to which elementary school teachers enjoy teaching science and their choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, or teacher emphasis method.

7d. There is no significant relationship between the degree to which elementary school teachers enjoy teaching science and their persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required per week.

The Attributional Model of Achievement Motivation (Weiner et al., 1978) and science teaching performance

8a. The 24 selected predictor variables are not significant predictors of elementary school teachers' persistence of science teaching performance as measured by their index of time allocation: their estimated actual science teaching time allocation per term, divided by the amount of time officially required.

8b. The 24 selected predictor variables are not significant predictors of elementary school teachers' choice of method for teaching science as measured by the Predicted Role Measure (Berger, 1972): student emphasis, student-teacher cooperation, and teacher emphais methods.

Subjects

The sample population of 236 elementary school teachers consisted of 26 males (11%) and 210 females (89%) from four community school districts in four boroughs of New York City who volunteered to participate in the study. Within each district, only regular teachers in self-contained classrooms who taught grades kindergarten through 6 were selected. Teachers in bilingual programs and teachers whose classes were taught science by a cluster teacher were not included in the present study. The subjects had an average of 12.033 years of teaching experience and a mean age of 41 through 50 years. The mean grade level taught was 3.093. The sample consisted of 141 teachers of grades kindergarten through 3 and 95 teachers of grades 4 through 6.

Materials

The subjects were administered four instruments in the following order:

1. Teacher Background Information Instrument (TBI) was developed by the researcher to measure some of the teachers' antecedents, enjoyment of science teaching and allocation of classroom time to science teaching.

2. Science Teaching Situations (STS) is a modification by the researcher of an instrument developed by Ickes (Ickes & Layden, 1978) to measure causal attributions and causal dimensions.

3. The Science Test of the Common Examinations of the National Teacher Examination (Educational Testing Service) served to measure

the teacher antecedent, knowledge of science content. The reliability for the science score on 30 items ranges between .79 and .81 as obtained from Kuder-Richardson estimates.

4. The Predicted Role Measure (PRM) was designed by Berger (1972) to predict the methods elementary school teachers would apply when teaching science. This instrument involves the use of a 16 mm. color film and an accompanying pamphlet of statements about the film. The film selected for the development of the PRM was Don't Tell Me, I'll Find Out (SCIS, 1968). In the development of the PRM, the content validity was established at .90 by a panel of experts at Lawrence Hall of Science, University of California at Berkeley. A predictive validity of .74 was established by raters who observed a subset of respondents who completed the instrument. Berger obtained a split-half reliability of .84 by administering the PRM to a group of 23 graduate students. In the present study, the reliability of the PRM was obtained from a pilot study involving 61 teachers in one New York City community school district who were similar to the subjects. An item analysis yielded a Cronbach's Alpha value of .708.

Procedures

Feasibility study. A feasibility study was carried out with the cooperation of seven elementary school teachers at a private day school to test the measuring instruments and procedures. As a result of the teachers' comments and responses, several changes were made in the wording and order of the items in the Teacher

Background Information (TBI) instrument, and the stem of one item in Science Teaching Situations (STS) was altered.

Permission to perform both the pilot study and the main study was obtained from the New York City Board of Education, the community superintendent of each school district, and the United Federation of Teachers. The investigator also received permission from the Educational Testing Service (ETS) to use the National Teacher Examination Science Test. ETS provided separate copies of their secure measure of science knowledge for the purpose of this study. Permission was also received from Carl F. Berger to use the Predicted Role Measure (PRM), his copyrighted instrument for measuring science teaching method (see Appendix A).

Pilot study. A pilot study was conducted in a community school district in Manhattan in December 1979 to determine the feasibility of the data collection procedures. Of the 190 teachers in the district who were considered eligible, 61 teachers attended the research session and completed the 4 instruments. Thus, the methods and procedures of the pilot study were found to be efficient for recruiting subjects and for administering the instruments.

Main study. The teachers who participated in the study were recruited from four New York City community school districts. In order to obtain a total minimum sample of 150 teachers all eligible teachers in 4 participating districts were recruited. Of those contacted, 236 teachers, 36% of those contacted, volunteered (see Table 15).

Table 15

Participation of Teachers in the Main Study by District

Community School District Borough	Number of Eligible Teachers	Number of Teachers Participating
Manhattan	72	27
Bronx	211	58
Brooklyn	188	50
Queens	187	101
Total	658	236

Administration of the instruments and collection of the data. Arrangements for a suitable site and adequate seating for the subjects were made with the district personnel. The investigator and a research assistant visited the site of each research session one day prior to conducting the study. Placement of the projector and screen for administering the PRM and other aspects of the research sessions were pretested. The research site was a public school auditorium or classroom within each participating school district.

On the day of the research session, the investigator and the research assistant assigned collated and numbered materials to the teachers as they arrived. The numbers assigned to the teachers were immmediately recorded next to their names on a roster of teachers in the district who had volunteered for the study. The teachers were instructed not to examine the materials until after

they received instructions at the start of the research session. Instead, they were invited to partake of refreshments that had been provided for them by the investigator. Each session began promptly at 3:30 p.m. and terminated by 5:00 p.m. During the research sessions, the investigator gave the instructions to the participants (see Appendix E), answered their questions, and monitored the procedures. The role of the research assistant was to project the film of the PRM and to otherwise assist in the research session. At the end of the session, the investigator and the assistant collected the completed materials before the teachers left.

The instruments were administered to the teachers uniformly in the following sequence:

1. Teacher Background Information Instrument (20 minutes)
2. Science Teaching Situations (20 minutes)
3. The Science Test of the National Teachers Examination (ETS) (15 minutes)
4. The Predicted Role Measure (PRM) (60 minutes)

Except for the Science Test (ETS), the teachers were required to respond to all items on every instrument. Teachers who could not complete all materials within the allotted time were allowed to remain after the session. No more than one or two teachers per session needed additional time to complete the questionnaires, and no teachers required more than an extra 5 or 10 minutes to finish all items. The Science Test, a standardized examination, was administered for 15 minutes as recommended by ETS. With few exceptions, the teachers did not complete all items on the Science Test.

Data analysis. After the data were collected in the field, the measuring instruments were hand scored by the investigator and an assistant. Computer cards were punched and verified at the Fordham University computing center and the Statistical Package for the Social Sciences (SPSS) (Nie et al., 1970) was utilized for the statistical analyses. The following statistical analyses were performed.

1. Means and standard deviations were obtained for the teacher antecedents, causal attributions, causal dimensions, causal effects, and criterion (performance) variables.

2. *t* tests were computed on mean scores of the teachers' causal attributions (ability, effort, task difficulty, and luck) for success and failure outcomes.

3. Pearson product-moment correlations were computed between: (a) antecedents and causal attributions, (b) antecedents and causal effects, (c) antecedents and science teaching performance, (d) causal dimensions and causal effects, (e) causal dimensions and science teaching performance, and (f) causal effects and science teaching performance. The correlations were performed to determine the relationship between the variables in the Attributional Model of Achievement Motivation when science teaching methods and allocation of time to science serve as the performance variables.

4. Four stepwise multiple regression analyses were performed to determine the most efficient regression equation for the 24 predictor variables of science teaching performance and each of 4

criterion variables of performance (a) time allocation for teaching science, and (b) three science teaching methods measured by the Predicted Role Measure (PRM): student emphasis, student-teacher cooperation, and teacher emphasis methods.

Findings of the Study

A summary of the results of the data analyses follows:

Causal Attributions (Hypothesis 1)

Significant differences were found among the mean scores of the four causal attributions within both the success and the failure conditions. In success situations, the four causal attributions were rated in the following descending order of magnitude: effort, ability, task difficulty, and luck. In failure situations, the descending order of magnitude in which the four causal attributions were rated was: task difficulty, luck, effort, and ability. Furthermore, mean scores of effort and ability attributions were significantly higher in the success condition than in the failure condition. However, no significant differences were found between the mean scores in the success condition and mean scores in the failure condition of task difficulty and luck attributions.

Antecedents and Causal Attributions (Hypothesis 2)

1. There were low, significant, and negative relationships in the success condition between the mean number of high school science courses completed by subjects and their attributions to effort and ability. There were no significant relationships in the success condition between the mean number of high school courses

completed by subjects and their attributions to task difficulty and luck. Also, there were no significant relationships in the failure condition between the mean number of high school courses completed by subjects and the four causal attributions.

There was a low, significant, and positive relationship in the success condition between the mean number of college science courses completed by subjects and their attributions to ability. There were no significant relationships in the success condition between the mean number of college science courses completed and teachers' attributions to effort, task difficulty, or luck. There were no significant reltionships in the failure condition between the number of college science courses completed and teachers' causal attributions.

There were no significant relationships in the success or the failure conditions between the number of graduate level science courses completed by subjects and their causal attributions.

2. There were no significant relationships in the success or the failure conditions between the number of science teaching methods courses completed by subjects and their causal attributions.

3. There was a low, significant, and negative relationship in the success condition between subjects' knowledge of science content and their effort attributions. There were no significant relationships in the success condition between subjects' knowledge of science content and their causal attributions to ability, task difficulty, and luck.

There were low, significant, and positive relationships in the failure condition between subjects' knowledge of science content and their attributions to effort and task difficulty. There were no significant relationships in the failure condition between subjects' knowledge of science content and their causal attributions to ability and luck.

4. There were low, significant, and positive relationships in the success condition between subjects' perceptions of the degree of their success in past science teaching and their causal attributions to effort and ability. There were no significant relationships between subjects' perceptions of the degree of their past success when teaching science and attributions to task difficulty and luck.

There were no significant relationships in the success or the failure conditions between subjects' perceptions of their degree of past success when teaching science and their attributions to task difficulty and luck.

Antecedents and Causal Effects (Hypothesis 3)

1. There was no significant relationship between subjects' perceptions of their degree of success in past science teaching and the degree of their expectancy shifts.

2. There was no significant relationship between subjects' knowledge of science content and the degree of their expectancy shifts.

3. There were no significant relationships between the number of science content courses completed by subjects in high school

or college and the degree of their expectancy shifts. However, there was a low, negative, and significant relationship between the number of graduate science courses completed by teachers and the degree of their expectancy shifts.

4. There was a low, negative, and significant relationship between the number of science teaching methods courses subjects completed and the degree of their expectancy shifts.

5. There were no significnt relationships between the number of science content courses completed by the subjects in high school, college, or graduate school and their degree of enjoyment of science teaching.

6. There was a low, significant, and positive relationship between the number of science teaching methods courses completed by subjects and their degree of enjoyment of science teaching.

7. There was a low, significant, and positive relationship between subjects' knowledge of science content and their degree of enjoyment of science teaching.

8. There was a moderate, significant, and positive relationship between subjects' perceptions of their degree of success in past science teaching and their degree of enjoyment of science teaching.

Antecedents and Science Teaching Performance (Hypothesis 4)

1. There were no significant relationships between the number of science content courses completed by the subjects in high school, college, or graduate school and their science teaching method scores.

2. There was a low, significant, and positive relationship between the number of science teaching methods courses completed by the subjects and their student-teacher cooperation method scores. There were no significant relationships between the number of science teaching methods courses subjects completed and their student emphasis and teacher emphasis methods scores.

3. There was no significant relationship between subjects' knowledge of science content and their science teaching methods scores.

4. There was a low, significant, and positive relationship between subjects' perceptions of their degree of past success in science teaching and their student emphasis method scores. There were no significant relationships between subjects' perceptions of their degree of past success in science teaching and their student-teacher cooperation and teacher emphasis methods scores.

5. There was a low, significant, and positive relationship between the number of science teaching methods courses subjects completed and their index of time allocation for teaching science.

6. There was no significant relationship between subjects' knowledge of science content and their index of time allocation for teaching science.

7. There were no significant relationships between the number of science content courses subjects completed in high school, college, or graduate school and their index of time allocation for teaching science.

8. There was no significant relationship between subjects' perceptions of the degree of their past success in science teaching and their index of time allocation for teaching science.

Causal Dimensions and Causal Effects (Hypothesis 5)

1. There was a low, significant, and positive relationship in the success condition between subjects' internality dimension and the degree to which they enjoy teaching science. There was no significant relationship in the failure condition between subjects' internality dimension and the degree to which they enjoy teaching science.

2. There was a low, significant, and positive relationship in the success condition between the subjects' stability dimension and the degree to which they enjoy teaching science. There was no significant relationship in the failure condition between the subjects' stability dimension and the degree to which they enjoy teaching science.

3. There was no significant relationship in the success condition between the subjects' internality dimension and their expectancy shifts. There was a low, significant, and positive relationship in the failure condition between the subjects' internality dimension and their expectancy shifts.

4. There was no significant relationship in the success condition between the stability of the subjects' causal dimensions and their expectancy shifts. There was a low, positive, and significant relationship in the failure condition between the stability of subjects' causal dimensions and their expectancy shifts.

Causal Dimensions and Science Teaching Performance (Hypothesis 6)

1. There were no significant relationships in the success or the failure conditions between the internality of the subjects' causal dimensions and their science teaching method scores.

2. There was no significant relationship in the success condition between the internality of the subjects' causal dimensions and their index of time allocation for teaching science. In the failure condition, there was a low, negative, and significant relationship between the internality of subjects' causal dimensions and their index of time allocation for teaching science.

3. There was no significant relationship in the success condition between the stability of subjects' causal dimensions and their science teaching methods scores. There was a low, significant, and negative relationship in the failure condition between the stability of subjects' causal dimensions and their student emphasis scores. However, there were no significant relationships in the failure condition between the stability of the subjects' causal dimensions and their student-teacher cooperation or their teacher emphasis scores.

4. There was no significant relationship in the success condition between the stability of the subjects' causal dimensions and their index of time allocation for teaching science. There was a low, positive, and significant relationship in the failure condition between the stability of the subjects' causal dimensions and their index of time allocation.

Causal Effects and Science Teaching Performance (Hypothesis 7)

1. There was a low, significant, and positive relationship between the subjects' degree of expectancy shift and their student emphasis method scores.

There was no significant relationship between the subjects' degree of expectancy shift and their teacher emphasis and student-teacher cooperation method scores.

2. There was no significant relationship between the subjects' degree of expectancy shift and index of time allocation for teaching science.

3. There was no significant relationship between subjects' degree of enjoyment of science teaching and their science teaching methods scores.

4. There was a low, positive, and significant relationship between subjects' degree of enjoyment of science teaching and their index of time allocation.

Predictors of Science Teaching Performance (Hypothesis 8)

1. There were three significant predictors of the subjects' index of time allocation for teaching science: number of science teaching methods courses, attribution of failure to effort (negatively), and attribution of success to ability.

2. There was one significant predictor of the subjects' student emphasis method scores: expectancy shift. There were no significant predictors of the subjects' student-teacher cooperation method and teacher emphasis method scores.

Conclusions

The purpose of this section is to report the conclusions derived from the results of the statistical analysis of the data.

Causal Attributions

Attribution theory is a branch of social psychology whose primary concern is to explain how individuals use informational cues to attribute causes for their own behavior and for the behavior of others (Bar-Tal, 1978). These causal attributions are important because they are perceptions that influence a person's emotional reactions, future outlook, and subsequent performance (Shaver, 1975). A model of causal attributions, first proposed by Weiner and his colleagues in 1971 and later elaborated by Weiner et al. (1978, p. 60, Table 3.1), has been shown to have validity in a wide range of social and achievement related contexts. In particular, investigators have demonstrated the efficacy of the attributional model for explaining students' classroom performance (Weiner, 1972a). A large number of empirical studies have emerged which have utilized attribution theory to explain how students (Bailey et al., 1975; Frieze et al., Note 1) and teachers (Ames, 1975; Beckman, 1970; Brandt et al., 1975; Cooper, 1977) assign responsibility for learning achievement in the classroom. These studies have provided valuable information about the relationship between causal attributions and student performance. However, studies that relate teachers' causal perceptions to their own performance outcomes appear to be missing from the literature.

In the present study, teachers' causal attributions for the success or failure of their own science teaching performance were measured. In the success condition, the mean scores of the four causal attributions were all significantly different from each other and were rated in the following descending order of magnitude: effort, ability, task difficulty, and luck. In failure situations, the mean scores of the four causal attributions were also all significantly different from each other and the descending order in which the four causal attributions were rated was: task difficulty, luck, effort, and ability.

Thus, when teaching outcomes were successful, the teachers showed a strong preference for internal causes or attributions (effort and ability) over external causes or attributions (task difficulty and luck). For failure outcomes, teachers strongly preferred external attributions (task difficulty and luck) over internal attributions (effort and ability). Furthermore, in success, the teachers' ratings of ability and effort (internal attributions) were significantly higher than under failure conditions. However, there were no significant differences in their ratings of task difficulty and luck (external attributions) under success and failure conditions. Therefore, it appears that the teachers' preference for internal attributions varies with performance outcome (success or failure), but their preference for exernal attributions does not change with outcome. Also, in the success condition the teachers preferred unstable attributions (effort and luck) over stable attributions

(ability and task difficulty). However, in the failure condition the teachers had no significant preference for stable or unstable attributions.

Since causal attributions are thought to result from antecedent factors such as an individual's past experience and bias, the Weiner model does not predict that a specific pattern of attributions will occur in success or failure situations. Therefore, it is of theoretical interest to compare the attributional styles of the teachers in the present study with those of subjects in previous studies involving other academic contexts because attributions are said to mediate between antecedents and performance. As stated earlier, attributional studies in which teachers are asked to explain the success or failure of their own classroom performance appear to be missing from the literature. Therefore, the results of two other lines of research in educational settings will be compared with the findings of the present study: (a) research in which students account for their performance outcome in a classroom setting and (b) research in which teachers explain the causes of their students' success or failure.

Student attributions for their own performance. Bailey et al. (1975) examined college students' reactions to their midterm examination performance. They asked students to choose the major cause of their exam grade from a list containing ability, effort, task difficulty, and luck as the possible causal factors. In their study, both successful and unsuccessful students strongly preferred

attributions to effort. Frieze et al. (Note 1) used a similar research paradigm in an attempt to verify the predictive validity of the attributional model in an actual classroom setting. They asked college students to explain their test performance in terms of the quality of instruction and the four causal attributions. The data obtained revealed that both students who scored high on the exam and those who scored low rated ability and effort above task difficulty and luck as causes of their performance outcome. Further supporting evidence of student preferences for ability and effort attributions in success and failure situations were reported by Arkin and Maruyama (1979).

Thus it appears that for success, students' high ratings of internal attributions parallel those of the teachers in the present study. However, in failure, the teachers' stronger preference for external attributions over internal ones differed sharply from the students' preference for internal attributions in the studies cited. Furthermore, a comparison of attributions along the stability dimension indicates that the direction of the students' attributions was substantially unchanged across success and failure situations. For example, students either tended to explain their success and failure in terms of stable attributions (Arkin & Maruyama, 1979; Frieze et al., Note 1) or unstable attributions (Bailey et al., 1975). Thus in these investigations, students appear to be consistent in their bias along the stability dimension of their causal attributions. However, the teachers in the present study were not

as consistent. In success, they preferred unstable attributions, but in failure, the teachers showed no significant preference in the stability of their causal attributions.

Teachers' attributions for their students' performance. Investigations involving the attributions of teachers have sought their explanations for the causes of student performance. Experimental researchers have asked teachers to assign responsibility for student success or failure to themselves or to their students. This research paradigm may contribute to an understanding of teachers' attributions along the dimension of internality. However, the evidence appears equivocal. Beckman (1972) and Ross et al. (1974) found that teachers attributed student success externally to the students and student failure internally to themselves. These findings would seem to contradict the findings of the present study that teachers prefer to attribute success internally and failure externally. However, Beckman (1970) and Johnson et al. (1964) found that the teachers' attributions were consistently less favorable to their students in low performance conditions and more favorable to themselves in high performance conditions. Recently, Cooper and Burger (Note 4) found that teachers perceived that they played a larger role when their students were successful than when their students were unsuccessful. In another study (Cooper & Burger, Note 4), teachers also gave themselves higher ratings as causes of student success than as causes of student failure. Bradley (1978) has suggested that in the experiments of Beckman (1972) and Ross et al. (1974)

subjects accepted responsibility for negative outcomes and credited positive outcomes to their students because research conditions provided for the possibility of an invalidation of their attributions through an objective assessment of their behavior, that is, the teachers were aware that their attributions for success or failure would be compared with attributions made by an observer to their teaching performance. Furthermore, in the experiment of Ross et al. (1974), the teachers also knew that their performance was being videotaped. However, under the conditions of the present study, the teachers' attributions could not be validated by others. According to Bradley, when research conditions do not threaten subjects with ongoing or future evaluations of their teaching performance, they can be expected to assign responsibility for successful outcomes to themselves.

Summary. The results of the analysis of teachers' attributional styles in the present study support the conclusions that in successful teaching situations, teachers tend to take attributions to internal causes. In failure situations, teachers tend to make attributions to external causes. Therefore, the findings of the present study are generally consistent with other attributional research involving teachers. Furthermore, for the success condition, the preference of teachers to make internal attributions also has its parallel in research measuring student attributions. However, in failure students retain their preference for internal attributions while the teachers in the study strongly preferred external

attributions. Further research is needed to help explain why students appear more willing than teachers to accept responsibility for failure in an academic context.

Previous research also showed that the stability of students' causal attributions did not change with outcome. However, in the present study, the teachers were less consistent than students in the stability of their causal attributions. In success, the preferred unstable attributions, but in failure the teachers had no significant preference in the stability of their attributions. The teachers' tendency to make unstable attributions in success situations results from their strong preference to attribute success to effort. The findings of the present study that teachers prefer internal attributions in success and external attributions in failure are also reported by experimental research involving teachers that have been reported in the literature.

The Attributional Model of Achievement Motivation

Although it has been assumed that attribution theory is generally applicable in a large variety of school settings (Weiner, 1976, 1979), most supportive research has been based on studies where student success or failure has served as the focus of the attributional process. The present study sought to validate the attributional model in an achievement-related situation involving the performance of teachers.

A major prediction of the Weiner model is that causal attributions and causal effects are the mediating variables between

antecedent factors in the teachers' background and their science teaching performance. To this end, the present study sought to detect relationships among the different components of the attributional model. However, the significant correlation coefficients obtained were of a low order of magnitude. Therefore, the results indicate that most of the relationships obtained in the present study were not meaningful. However, two pairs of relationships which were of higher magnitude may provide some direction for further investigation.

Antecedents and causal attributions. According to Weiner (1976), antecedents serve as sources of information which individuals process in order to explain their success or failure in an achievement-related context. The present study sought to determine the relationships between antecedent factors in the teachers' background and their causal attributions. Teacher antecedents that were studied were: number of science content courses completed in high school, college, and graduate school; training in science teaching methods; perception of past science teaching as successful; and knowledge of science content.

Most of the relationships between these antecedent factors and the teachers' causal attributions proved to be very weak. However, the relationship between the teachers' perceptions of their degree of past success and their attribution to ability appears to be more meaningful. Teachers who rated their past science teaching as successful also tended to attribute success to greater ability.

Thus, the attributional style of teachers with higher self-perceptions appears to contrast with the general preference of the teachers in the present study for attributions to effort. However, Nicholls (1976) has concluded that in situations where present success has implications for future performance, subjects with higher self-concepts will prefer ability over effort attributions. Furthermore, Luginbuhl, Crowe, and Kahan (1975) attempted to explain why some subjects prefer to attribute success to a factor over which they have no control (ability) rather than one which they do control (effort). According to Luginbuhl et al. (1975),

> If a successful performance on a given task is not important to the individual, then it is of little benefit to attribute success to one's ability. It may be more rewarding to attribute success to effort since we all have been taught that one should try. (p. 93)

Therefore, in the present study the apparent difference in teachers' attributional styles (ability vs. effort attributions) may be related to the importance or priority that the higher self-rating teachers assign to science within the elementary curriculum.

Perception of past science teaching and affect. A moderately positive correlation was obtained between the teachers' perceptions of their past success and their enjoyment of science teaching. Teachers who tended to have high perceptions of their past success also expressed greater enjoyment for teaching science. This finding is consistent with the results of Frieze et al. (Note 1) which showed that perceptions of subjective success are more important for predicting affective reactions than are objective factors. Compared

to the generally low-order relationships obtained between antecedents and causal attributions, the emergence of a moderately strong association between an antecedent factor and enjoyment is surprising. But Weiner et al. (1978) have asserted that in addition to specific causal attributions and causal dimensions, reactions to success and failure may also produce strong emotional responses. Furthermore, Bailey et al. (1975) have shown that affect resulting from performance outcome may be completely unrelated to causal attributions and causal dimensions. Thus it appears that teachers who think that they are more successful expressed greater enjoyment for science teaching as an emotional response to success rather than as a result of the attributional process.

Summary. A major purpose of the present study was to determine if the relationships obtained between teachers' antecedents, causal attributions, causal dimensions, causal effects, and science teaching performance, are predicted by the attributional model (Weiner et al., 1978). However, the anticipated relationships between the variables were mostly of a low level of magnitude and did not provide unequivocal support for the theoretical model. However, two meaningful relationships were obtained. Teachers who perceived that their past science teaching was successful tended to attribute success to ability. Also, high self-perception of past teaching success was associated with greater enjoyment in teaching science. Therefore, the teachers' antecedent self-perceptions appear to be related to both their causal attributions and their affect for science teaching within the theoretical framework.

In the study by Nicholls (1976) cited above, it was found that more positive affect was associated with ability attributions in subjects with high self-concepts and with effort attributions in subjects with low self-concepts. Furthermore, Frieze et al. (Note 1) found that affect following an academic task was more positively correlated with ability than with effort ratings. Thus, these limited findings of the present study are consistent with other attributional research within an educational setting.

However, other results obtained in the present study appear to refute the attributional model. For example, no meaningful relationships were obtained between causal dimensions, causal effects, and performance variables. Nonetheless, the findings in the present study are consistent with the findings of other investigators who have tried to test the model in an educational setting. For example, Bailey et al. (1975) attempted to determine the effects of success and failure on a midterm examination on students' attributions, affect, and expectancy. Bailey et al. (1975) concluded that their apparent failure to demonstrate the anticipated effects was due to differences between their research design and the laboratory investigations on which the model is based. According to Bailey et al. (1975), laboratory-based investigations involving simple tasks do not always produce findings that can be replicated in a real-life situation. In addition, Frieze et al. (Note 1) have found that the attributional process in the classroom seems to require a more complex model than that proposed by Weiner et al. (1978).

A further explanation for the lack of congruence between the present findings and the proposed model may be inherent in the nature of the dependent variables. In the present study, performance is defined in terms of two aspects of science teaching: teaching method and time allocation. In other attribution research performance is defined in terms of a more immediate achievement-related task, e.g., a block design puzzle (Weiner et al., 1976), a digit-symbol substitution (Weiner et al., 1972), or an important examination (Bailey et al., 1975; Frieze et al., Note 1). Therefore, the performance variables in the present study may be too global and too long range to yield clearly defined results. However, despite the inconsistencies and the low level in the magnitude of the correlations obtained, the findings do appear to suggest that causal perceptions are more important than teacher background factors in contributing to the attributional process.

The Predictors of Science Teaching Performance

Twenty-four independent variables were used to predict two indicators of science teaching performance: index of time allocation and choice of science teaching method. In the present study, teaching methods were measured in terms of the three roles defined by Berger (1972): student emphasis, student-teacher cooperation, and teacher emphasis roles. Therefore, there were four criterion variables in the present study. The 24 predictor variables consisted of 10 teacher antecedents, 8 causal attributions, 4 causal dimensions, and 2 causal effects. Stepwise regression analyses were applied

in order to determine the most efficient predictors of the four measures of science teaching performance.

Index of time allocation. There were three significant predictors of time allocation that, in total, accounted for 7.3% of the criterion variance. The three predictors in the order selected were: number of science teaching methods courses, attribution of failure to lack of effort (negatively), and attribution of succes to ability.

The first predictor of time allocation is an antecedent variable, number of science teaching methods courses completed. This finding has interesting implications for the preservice and inservice training of elementary school teachers. However, the teachers' training in science teaching methods was not related to their causal attributions in the present study. Therefore, the findings obtained are not fully consistent with the attributional model which predicts that causal attributions and causal effects mediate between antecedent factors and performance. The other two predictors of time allocation are both causal attributions. The attributional model predicts that attribution of success to stable causes and of failure to unstable causes will increase persistence of performance (Weiner, 1979). The findings of the present study for success situations are supportive of the theoretical model. However, in failure situations, the direction of the relationship runs contrary to the theory. Therefore, the finding that teachers who tend to overlook the efficacy of effort for averting negative teaching outcomes also allocate more time to science was not anticipated.

Science teaching methods. Of the three methods of science teaching measured in the present study, only the student emphasis method proved to have a significant predictor, namely, expectancy shift, which accounted for only 2.2% of the criterion variance. This finding is consistent with the attributional model which postulates a direct linkage between causal effects and achievement-oriented performance. The variables that were found to be predictors of time allocation and science teaching method do indicate to a very limited extent that causal cognitions contribute to science teaching behaviors. However, the attributional model also predicts that affect directly influences persistence and choice of performance. The notable absence of enjoyment of science teaching from the list of significant predictors was not anticipated and requires clarification through further research.

Summary. For science teaching methods, only one predictor, expectancy shift, was identified with the student emphasis role. No significant predictors of the student-teacher cooperation or the teacher emphasis methods were found. The number of science teaching methods courses completed by the teachers and two causal attributions (success to ability, and negatively, failure to lack of effort) were identified as the three predictors of index of time allocation. However, these predictors accounted for only a small fraction of the variance in science teaching performance. A possible interpretation of these results is that the teachers' antecedent factors and causal cognitions as identified in this study are not

important predictors of their own teaching performance. It appears that other factors in the teaching environment may be more closely associated with how science is taught than the teachers' preparation and willingnes to teach science in the elementary school.

Implications of the Study

The findings of the current study suggest the following implications:

1. Teachers should receive more training in elementary science teaching methods. Although the teachers in the study had an average of 12.033 years of teaching experience, the average number of science teaching methods courses they had completed was only 1.659. This would indicate that a large segment of the sample population received no training in science teaching methods after they completed their certification requirements. Many teachers are probably not aware of the new methods and materials of the recent elementary science curriculum projects or of their instructional merits. The present study has demonstrated that increased teacher training in science teaching methods is associated with larger time allocations for science teaching.

2. Teachers in the present study demonstrated distinct attributional styles in success and failure situations. Furthermore, it appears that teachers with higher self-ratings for their science

teaching have enhanced feelings of competence and also express greater enjoyment for science teaching. The implications of these findings are that science educators and school administrators should provide preservice and inservice training to enhance teachers' perceptions of mastery of science teaching skills.

3. School districts and administrations should provide adequate supervisory support for science instruction. The findings of the present study indicate that the teachers allocate substantially less time to science teaching than is required by New York City and State boards of education, or than is practiced on a national level. Principals should set a higher priority for science. Teachers would be more likely to spend more time teaching science if it were valued as part of the basic curriculum.

Recommendations for Further Research

1. The present study measured four causal attributions (ability, effort, task difficulty, and luck) and one form of affect in elementary school teachers. Although the attributions measured in the present study are the ones most often investigated in attribution research, other studies have demonstrated that subjects infer a wider variety of causes in explaining their success or failure in an achievement-related context. Subjects have also been shown to exhibit a broader range of affective reactions than enjoyment alone. Research employing open-ended instruments might be utilized

to determine if there are other important causal attributions and affective reactions that are related to science teaching performance.

2. Research on teachers in other contexts is needed to determine if the attributional styles demonstrated in the present study are characteristic of the teaching of other elementary school subjects or of other groups of elementary school teachers.

3. The present study investigated the attributional styles and science teaching performance of elementary school teachers who were not science specialists. A study which compares and contrasts regular classroom teachers with science cluster teachers on attributional and performance variables might yield important implications for the teaching of elementary science.

4. Significant relationships and predictor variables obtained in the present study should be investigated under experimental conditions in a more restricted framework. For example, an experimental paradigm may be devised to determine the conditions under which antecedent factors or causal cognitions influence science teaching performance.

5. The teacher antecedents selected for study in the present research effort may not be the critical factors relating to science teaching performance. Future research should explore variables that may have a greater impact upon science instruction in the elementary school. In particular, factors in the teaching environment such as administrative priorities, supervisory support, and the

availability of curriculum materials and science supplies are factors that are external to teachers, which may be related to their persistence in time allocation and their choice of method for teaching science.

REFERENCE NOTES

1. Frieze, I. H., Snyder, H. N., & Fontaine, C. N. Student attributions and the attribution model during an actual examination. Paper presented at the Annual Meeting of the American Psychological Association, San Francisco, 1977.

2. Shulman, L. L. Research in teaching: The missing link in curriculum implementation. Paper presented at the Bat-Sheva Seminar on Curriculum Implementation and Its Relationship to Curriculum Development in Science, Jerusalem, Israel, Summer 1978.

3. Clark, C. M., & Yinger, R. J. Research on teacher thinking (Institute for Research on Teaching, Research Series No. 12). Lansing: College of Education, Michigan State University, 1978.

4. Cooper, H. M., & Burger, J. M. Internality, stability, and personal efficacy: A categorization of free response academic attributions (Center for Research in Social Behavior, Technical Report No. 139). Columbia: University of Missouri-Columbia, May 1978.

5. Harris, T., & Yinger, R. Time. In The Institute for Research on Teaching, Current directions in research on teaching (Conference Series No. 1). Lansing: College of Education, Michigan State University, 1978.

REFERENCES

Ames, R. Teachers' attributions of responsibility: Some unexpected nondefensive effects. Journal of Educational Psychology, 1975, 57, 668-675.

Arkin, R. M., & Maruyama, G. M. Attribution, affect, and college exam performance. Journal of Educational Psychology, 1979, 71, 85-93.

Bailey, R. C., Helm, B., & Gladstone, R. The effects of success and failure in a real-life setting: Performance, attribution, affect, and expectancy. Journal of Psychology, 1975, 89, 137-147.

Bar-Tal, D. Attributional analysis of achievement-related behavior. Review of Educational Research, 1978, 48, 259-271.

Bar-Tal, D., Leinhardt, G., & Bar-Tal, Y. Effect of an innovative program on perceptions of locus of control and satisfaction. Science Education, 1978, 62, 349-357.

Beckman, L. Effects of students' level and patterns of performance on teachers' and observers' attribution of causality. Journal of Educational Psychology, 1970, 61, 76-82.

Beckman, L. Teachers' and observers' perceptions of causality for a child's performance. Journal of Educational Psychology, 1972, 62, 198-204.

Berger, C. F. Predictions of teaching behaviors by teachers of elementary school science (Doctoral dissertation, University of California, Berkeley, 1971). Dissertation Abstracts International, 1972, 33, 4459A. (University Microfilms No. 72-6459)

Berger, C. F. Change in predicted teacher behavior based on experience with an activity oriented elementary science course. Presented at the Annual Meeting of the National Association for Research in Science Teaching, Detroit, March 1973. (ERIC Document Reproduction Service No. ED 080 310)

Borg, W. R., & Gall, M. D. Educational research: An introduction (3rd ed.). New York: Longman, Inc., 1979.

Bowyer, J. B., & Linn, M. C. Effectiveness of the science curriculum improvement study in teaching scientific literacy. Journal of Research in Science Teaching, 1978, 15, 209-219.

Bradley, G. W. Self-serving biases in the attribution process: A reexamination of the fact or fiction question. Journal of Personality and Social Psychology, 1978, 36, 56-71.

Brandt, L. J., Hayden, M. E., & Brophy, J. E. Teachers' attitudes and ascription of causation. Journal of Educational Psychology, 1975, 67, 677-682.

Bruning, J. L., & Kintz, B. L. Computational handbook of statistics (2nd ed.). Glenview, Ill.: Scott, Foresman, & Company, 1977.

Buccino, A., Dessart, D. J., Levine, H. P., & Rivkin, M. S. Science education databook. Washington, D.C.: Directorate for Science Education, National Science Foundation, 1980.

Buros, O. K. Mental measurements yearbook (Vol. 1). Highland Park, N.J.: Gryphon Press, 1978.

Butts, D. P. Elementary school science: A 1975 reflection. High School Journal, 1976, 59, 193-197.

Carpenter, R. A reading and an activity method in elementary science instruction. Science Education, 1963, 47, 256-258.

Chapin, M., & Dyck, D. G. Persistence in children's reading behavior as a function of n-length and attribution retraining. Journal of Abnormal Psychology, 1976, 85, 511-515.

Cooper, H. M. Controlling personal rewards: Professional teacher's differential use of feedback and the effects of feedback on the student's motivation to perform. Journal of Educational Psychology, 1977, 69, 419-427.

Dahloff, U. Ability grouping, content validity, and curriculum process analysis. New York: Teachers College Press, 1971.

Davis, T., Raymond, A., Mac Rawls, C., & Jordan, J. A comparison of achievement and creativity of elementary school students using project vs. textbook programs. Journal of Research in Science Teaching, 1976, 13, 202-212.

Diener, C. I., & Dweck, C. S. An analysis of learned helplessness: Continuous changes in performance, strategy, and achievement cognitions following failure. Journal of Personality and Social Psychology, 1974, 29, 487-496.

DiLorenzo, L. T., & Halliwell, J. W. A comparison of the science achievement of sixth grade pupils instructed by regular classroom and special science teachers. Science Education, 1963, 47, 202-205.

Dweck, C. S. The role of expectations and attributions in the alleviation of learned helplessness. Journal of Personality and Social Psychology, 1975, 31, 674-685.

Dweck, C. S., & Goetz, T. E. Attributions and learned helplessness. In J. H. Harvey, W. Ickes, & R. F. Kidd (Eds.), New directions in attribution research: Volume II. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1978.

Elig, T. W., & Frieze, I. H. Measuring causal attributions of success and failure. Journal of Personality and Social Psychology, 1979, 37, 621-634.

Fisher, C. W., Marliave, R. S., Filby, N. N., Cahen, L. A., Moore, J. E., & Berliner, D. C. A study of instructional time in grade 2 mathematics. Far West Laboratory for Educational Research and Development, 1976. (ERIC Document Reproduction Service No. ED 147 186)

Fontaine, G. Social comparison and some determinants of expected personal control and expected performance in a novel task situation. Journal of Personality and Social Psychology, 1974, 29, 487-496.

Frieze, I. H. Causal attributions and information seeking to explain success and failure. Journal of Research in Personality, 1976, 10, 293-305.

Gage, N. L. The scientific basis of the art of teaching. New York: Teachers College Press, 1978.

Good, R., & Matthews, C. Relationships between classroom behavior and cognitive development characteristics in elementary school children. Journal of Research in Science Teaching, 1976, 13, 533-538.

Good, R., Matthews, C. C., Shymansky, J. A., & Penick, J. Relationships between classroom behavior and cognitive development characteristics in elementary school children. Journal of Research in Science Teaching, 1976, 13, 533-538.

Gullickson, A. Elementary science curriculum dissemination in the midwest. Journal of Research in Science Teaching, 1978, 15, 479-484.

Harnischfeger, A., & Wiley, D. E. The teaching-learning in elementary schools. Curriculum Inquiry, 1976, 6, 5-43.

Heckhausen, H. Fear of failure as a self-reinforcing motive. In C. D. Speilberger & J. G. Sarason (Eds.), Stress and anxiety (Vol. 2). Washington, D.C.: Hemisphere Press, 1975.

Helgeson, S. L., Blosser, P. E., & Howe, R. W. The status of pre-college science, mathematics, and social science education: 1955-1975 (Vol. 1: Science education; prepared for the National Science Foundation, Directorate of Science Education, SE 78-73). Washington, D.C.: U.S. Government Printing Office, 1977.

Hone, E. Science Scarecrows. School Science and Mathematics, 1970, 70, 322-326.

Ickes, W., & Layden, M. A. Attributional styles. In J. H. Harvey, W. Ickes, & R. F. Kidd (Eds.), New directions in attribution research: Volume II. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1978.

Johnson, T. J., Feigenbaum, R., & Weiby, M. Some determinants and consequences of the teacher's perception of causation. Journal of Educational Psychology, 1964, 55, 237-246.

Krockover, G. H., & Malcolm, M. D. The effects of the SCIS on a child's self-concept. Journal of Research in Science Teaching, 1977, 14, 295-299.

Kukla, A. Attributional determinants of achievement-related behavior. Journal of Personality and Social Psychology, 1972, 27, 166-174.

Lavatelli, C. S., Moore, W. J., & Kaltsounis, T. Elementary school curriculum. New York: Holt, Rinehart, & Winston, 1972.

Lowery, L. F., Bowyer, J., & Padilla, M. J. The SCIS and student attitudes. Journal of Research in Science Teaching, 1980, 17, 327-335.

Luginbuhl, J. E., Crowe, D. H., & Kahan, J. P. Causal attributions for success and failure. Journal of Personality and Social Psychology, 1975, 31, 86-93.

Maeroff, G. I. School science struggles less successfully than ever. The New York Times, July 2, 1978, p. E16.

Maracek, J., & Mettee, D. Avoidance of continued success as a function of self-esteem, level of esteem certainty, and responsibility for success. Journal of Personality and Social Psychology, 1972, 22, 98-107.

McMahan, I. D. Relationships between causal attributions and expectancy of success. Journal of Personality and Social Psychology, 1973, 28, 108-115.

Nelson, B. J. Correlational relationships between the role of the elementary teacher while teaching science and the science teaching practices used. Science Education, 1978, 62, 53-58. (a)

Nelson, B. J. The relationship of fifth and sixth grade students' achievement to preservice science teacher preparation. Journal of Research in Science Teaching, 1978, 15, 161-166. (b)

New York City Board of Education. Science curriculum bulletins. New York: Bureau of Curriculum Development, 1965-1972.

Nicholls, J. G. Effort is virtuous, but it's better to have ability: Evaluative responses to perceptions of effort and ability. Journal of Research in Personality, 1976, 10, 306-315.

Nie, N. H., Hull, C. H., Jenkins, J. G., Steinbrenner, K. G., & Bent, D. H. Statistical package for the social sciences (2nd ed.). New York: McGraw-Hill, 1975.

Nimmer, D. N. Differences in how elementary science teachers learn to use their curricula and their satisfaction with their curricula. School Science and Mathematics, 1977, 77, 671-674.

Nunnally, J. D. Psychometric theory. New York: McGraw-Hill, 1978.

Penick, J. Creativity in fifth-grade science students: The effects of two patterns of instruction. Journal of Research in Science Teaching, 1976, 13, 307-314.

Penick, J., Shymansky, J. A., Matthews, C. C., & Good, R. Studying the effect of two quantitatively defined teaching strategies on student behavior in elementary school science using microanalytic techniques. Journal of Research in Science Teaching, 1976, 13, 289-296.

Perkes, Y. E. Relationship between a teacher's background and sensed adequacy to teach elementary science. Journal of Research in Science Teaching, 1975, 12, 85-88.

Powell, N. Variability of teacher behaviors. Practical Applications of Research (Newsletter of Phi Delta Kappa), September 1978, n.p.

Roscoe, J. T. Fundamental research statistics for the behavioral sciences (2nd ed.). New York: Holt, Rinehart, & Wilson, 1975.

Ross, L., Bierbrauer, G., & Polly, S. Attribution of educational outcomes by professional and non-professional instructors. Journal of Personality and Social Psychology, 1974, 29, 609-618.

Schwirian, C. Characteristics of elementary teachers related to attitudes towards science. Journal of Research in Science Teaching, 1969, 6, 203-216.

Seligman, M. E. P., & Maier, S. F. Failure to escape traumatic shock. Journal of Experimental Psychology, 1967, 74, 1-9.

Shaver, K. G. An introduction to attribution processes. Cambridge, Mass.: Winthrop Publishers, 1975.

Shrigley, R. L. The function of professional reinforcement in supporting a more positive attitude of elementary teachers toward science. Journal of Research in Science Teaching, 1977, 14, 317-322.

Shymansky, J. A. How is student performance affected by the one-to-one teacher-student interactions occurring in an activity-centered science classroom. Journal of Research in Science Teaching, 1976, 13, 253-258.

Shymansky, J. A., & Matthews, C. C. A comparative laboratory study of the effects of two teaching patterns on certain aspects of the behavior of students in fifth-grade science. Journal of Research in Science Teaching, 1974, 11, 157-168.

Sohn, D. Affect generating powers of effort and ability self-attributions of academic success and failure. Journal of Educational Psychology, 1977, 69, 500-505.

Soy, E. M. Attitudes of prospective elementary teachers toward science as a field of specialty. School Science and Mathematics, 1967, 67, 507-517.

Strawitz, B. Open-mindedness and attitudes about teaching science. Journal of Research in Science Teaching, 1977, 14, 545-549.

Symington, D. J., & Fensham, P. J. Elementary school teachers' closed-mindedness, attitudes toward science, and congruence with a new curriculum. Journal of Research in Science Teaching, 1976, 13, 441-447.

Thier, H. Teaching elementary school science: A laboratory approach. Lexington, Mass.: D. C. Heath & Company, 1970.

University of the State of New York. Science for children, K-3 and 4-6 (2 vols.). Albany, N.Y.: Author, 1963.

University of the State of New York: The standard school curriculum. Albany, N.Y.: Author, 1978.

Vinci, T. G. An analysis of elementary science handbooks and their relationship to science programs in three districts in New York City. Unpublished doctoral dissertation, Teachers College, Columbia University, 1966.

Weiner, B. Attributional theory, achievement motivation, and the educational process. Review of Educational Research, 1972, 42, 203-215. (a)

Weiner, B. Theories of motivation: From mechanism to cognition. Chicago: Rand McNally College Publishing Company, 1972. (b)

Weiner, B. Achievement motivation as conceptualized by an attribution theorist. In B. Weiner (Ed.), Achievement motivation and attribution theory. Morristown, N.J.: General Learning Press, 1974.

Weiner, B. An attributional model for educational psychology. In L. Shulman (Ed.), Review of research in education (Vol. 4). Itasca, Ill.: Peacock, 1976.

Weiner, B. Attribution and affect: Comments on Sohn's critique. Journal of Educational Psychology, 1977, 69, 506-511.

Weiner, B. A theory of motivation for some classroom experiences. Journal of Educational Psychology, 1979, 71, 3-23.

Weiner, B., Frieze, I., Kukla, A., Reed, L., Rest, S., & Rosenbaum, R. Perceiving the causes of success and failure. Morristown, N.J.: General Learning Press, 1971.

Weiner, B., Heckhausen, H., Meyer, W., & Cook, R. Causal ascriptions and achievement behavior: A conceptual analysis of effort and reanalysis of locus of control. Journal of Personality and Social Psychology, 1972, 21, 239-248.

Weiner, B., & Kukla, A. An attributional analysis of achievement motivation. Journal of Personality and Social Psychology, 1970, 15, 1-20.

Weiner, B., Nierenberg, R., & Goldstein, M. Social learning (locus of control) versus attributional (causal stability) interpretations of expectancy of success. Journal of Personality, 1976, 44, 52-68.

Weiner, B., Russell, D., & Lerman, D. Affective consequences of causal ascriptions. In J. H. Harvey, W. Ickes, & R. F. Kidd (Eds.), New directions in attribution research: Volume II. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1978.

Weiner, B., & Sierad, J. Misattribution for failure and enhancement of achievement strivings. Journal of Personality and Social Psychology, 1975, 31, 415-421.

White, K., & Howard, J. L. The relationship of achievement responsibility to instructional treatments. Journal of Experimental Education, 1970, 39, 78-82.

White, M. A., Raun, C., & Butts, D. A study of contrasting patterns of inservice education. Austin, Texas: University of Texas, Science Education Center, 1967. (ERIC Document Reproduction Service No. ED 021 807)

Wiley, D. E. Another hour, another day: Quantity of schooling, a potent path for policy. In W. H. Sewell, R. M. Hauser, & D. I. Featherman (Eds.), Schooling and achievement in American society. New York: Academic Press, 1976.

Yager, R. E. Priorities for research in science education: A study committee report. Journal of Research in Science Teaching, 1978, 15, 99-107.

APPENDIX A

CORRESPONDENCE

BOARD OF EDUCATION OF THE CITY OF NEW YORK
OFFICE OF EDUCATIONAL EVALUATION
110 LIVINGSTON STREET, BROOKLYN, N. Y. 11201

ALAN S. BLUMNER, PH.D.
ACTING DIRECTOR

RICHARD T. TURNER, PH.D.
ASST. ADMIN. DIRECTOR

March 7,1979

Ms. Mildred R. Green
Adjunct Instructor - Graduate School of Education
Fordham University, Lincoln Center Campus
Columbus Avenue at 60th Street
New York, New York 10023

Dear Ms. Green:

I am happy to inform you that your proposed study entitled, "ELEMENTARY TEACHERS'ATTRIBUTIONAL STYLES AND THEIR SCIENCE TEACHING PERFORMANCE", has been approved by the Office of Educational Evaluation, with the following conditions:

1. Your report of the study should not include identification of any school or school personnel. A code system should be used.

2. You must make it very clear to your prospective respondents that their cooperation is on a purely voluntary basis.

Whenever your report is ready, I would be interested in receiving a copy.

Best wishes in this endeavor.

Sincerely yours,

Alan S. Blumner
Acting Director

ASB:gew
Encls.

P.S. You may duplicate this letter in any quantity you need in order to inform cooperating principals and community superintendents that you have received approval from the Office of Educational Evaluation.

United Federation of Teachers

Local 2, American Federation of Teachers, AFL-CIO
260 Park Avenue South
New York, N.Y. 10010
(212) 777-7500

February 14, 1979

Mrs. Mildred R. Green
Graduate School of Education
at Lincoln Center
Fordham University
Columbus Avenue & West 60th Street
New York, New York

Dear Mrs. Green:

We are pleased to cooperate with your science research project which we believe may help to reinforce the teaching of science in the elementary schools.

You will find UFT teachers are always eager to enrich their curriculum and develop new teaching strategies.

Sincerely,

ABE LEVINE
Vice-President
Assistant to the President

AL:dlr
opeiu:153

M. Green

MAR 23 1979

EDUCATIONAL TESTING SERVICE PRINCETON, N.J. 08540

Area Code 609
921-9000
CABLE-EDUCTESTSVC

Teacher Programs and Services

March 21, 1979

Dr. Anthony C. Mottola, Dean
School of Education at Lincoln Center
Fordham University
New York, NY 10023

Dear Dean Mottola:

I am authorizing the release of a confidential inspection copy of the NTE Common Examinations. The test is being forwarded under separate cover by certified mail for review by Ms. Mildred Green in her doctoral research study. The test is being released with the understanding that you will:

1. keep the test under lock and key at all times when it is not actually being inspected;
2. permit inspection of the test by other staff members only in your continuous presence;
3. safeguard the inspection of the test so that notes or transcripts of its content cannot be made; and
4. return the test by certified mail in thirty days.

Please sign and return the enclosed Confidential Inspection Copy Request Form for our records.

We are pleased to be of service to you and Ms. Green. Please let me know if I can be of further assistance regarding the National Teacher Examinations program.

Sincerely,

M. Ruth Nelson
Administrative Assistant
National Teacher Examinations

mrn

Enclosures

Ms. Green, expecting it
Monday, 3/26, 2:00 PM

SCHOOL OF EDUCATION
Office of the Dean
Corner East and South University Avenues
Ann Arbor, Michigan 48109
Telephone (313) 764-9470

THE UNIVERSITY OF MICHIGAN

November 28, 1979

Ms. Mildred R. Green
Adjunct Instructor
Division of Curriculum and Teaching
School of Education at Lincoln Center
Fordham University
New York, NY 10023

Dear Ms. Green:

Hurray, hurray! It's a pleasure to see your proposal in its final stages of production, and I'm also pleased to give you permission to use the predicted role measure for your research. Please reproduce as many copies of the device as you need. Note that I have enclosed the latest revision plus a copy of a chapter in a recent ERIC publication on Attitudes Toward Science: Investigations by Piper and Moore that will give you some further references for your dissertation. We have just completed at factor analytic study on the predicted role measure using a population of over 2,000 teachers and we find that the principal components fall into three major categories. The first is the degree of agreement or disagreement by teachers of number of differing behaviors they would use while teaching science. The second component, a scale component of teacher orientation to student orientation, and the third which is teacher-student cooperation orientation. As soon as this paper is written up, which it will be shortly, I will send you a copy. I hope this information assists you in your work at Fordham, and I look forward to seeing another document--your dissertation.

Thank you very much for considering the use of the predicted role measure; I hope it lives up to your expectations of it and our previous use of it.

Sincerely,

Carl F. Berger
Associate Dean

CFB:mm

enclosure

School of Education at Lincoln Center

F O R D H A M U N I V E R S I T Y *New York, N. Y. 10023*

November 7, 1979

Dear

I am conducting research on science education in the elementary school under the auspices of the School of Education at Fordham University. The purpose of this study is to describe teachers' preferences when teaching science. The results of this research should have important implications for teacher training, and ultimately for the improvement of the science education of children.

This research effort depends upon the participation of a large number of classroom teachers of grades kindergarten through six who are not specialists in science. The New York City Board of Education and the United Federation of Teachers have given their approval to the recruitment of teachers to participate voluntarily in this project. Your district's cooperation has made it possible for the study to be conducted after school hours at district headquarters. Teachers who are randomly selected to participate in this study will be contacted by letter (see the sample enclosed). Those who volunteer will be compensated at the Union per session rate and in addition, will receive a science teaching aid. Their participation in this research will be confidential and information about individuals will not be released.

The cooperation of every principal in the district will be needed to help make this project successful. In order to contact the teachers in your school, I will need your organization sheet. Because this research involves a strictly defined population of teachers, could you please indicate the following directly on the organization sheet.

(Please continue on the next page)

a. Place an X next to the name of any regular classroom teacher whose class normally receives any science instruction from a specialist or a cluster teacher.

b. Place a check ( ) next to the name of any regular classroom teacher who teaches in a language other than English for more than one-half hour each day.

c. Place a zero (0) next to the name of any person who is not a regular classroom teacher.

You can contribute greatly by returning your school's organization sheet in the enclosed envelope within a week. Thank you for your assistance in furthering this research project. I look forward to sharing the results with you. If you have any questions, please call me at Fordham, 841-5463.

Sincerely,

Mildred R. Green,
Adjunct Instructor

Enclosures

School of Education at Lincoln Center

FORDHAM UNIVERSITY New York, N.Y. 10023

ELEMENTARY SCIENCE EDUCATION PROJECT

November 16, 1979

Dear Teacher:

Because of your commitment to teaching and learning, I think you will be interested in a research project in science education that is being conducted under the auspices of the School of Education at Fordham University. The purpose of this study is to describe teacher's preferences when teaching science. The results should be useful in helping teachers to teach science, and ultimately, in improving the science education of children.

This research effort depends upon the participation of a selected number of classroom teachers of grades kindergarten through six who are not specialists in science. The New York City Board of Education and the United Federation of Teachers have given their approval to the recruitment of teachers who volunteer to participate in this project.

The cooperation of District 1 has made it possible for this study to be conducted between 3:30 pm and 5:00 pm at the district headquarters, 80 Montgomery Street, New York New York 10002, on Tuesday, December 11. At that time, you and other teachers from the district can meet in a pleasant and relaxed atmosphere. Refreshments will be available.

A large part of the time will be spent viewing and responding to a film on science education. Only one word or check off type responses will be required. You will be compensated at the Union per session rate. Also, in acknowledgement of your active role in this project, you will receive a science teaching aid. Participation in this research will be confidential and information about individuals will not be released.

This research will afford you an interesting professional experience that you will not want to miss. Please help insure the success of this project by completing and returning the response card in the envelope that has been provided. Your assistance in furthering this research will be greatly appreciated. I look forward to thanking you personally for your decision to join in this effort.

Sincerely,

Mildred R. Green,
Project Director

APPENDIX B

TEACHER BACKGROUND INFORMATION INSTRUMENT

COVER SHEET

Teacher number _____

School _____

School address _____

_____

Mailing address _____

_____

Date _____

District _____

Teacher Background Information

1. How many years have you been teaching? (exclude substitute teaching) _____

2. Circle the grade level you teach: K 1 2 3 4 5 6

3. Circle your gender: female male

4. Circle your age range:
   21-25 26-30 31-35 36-40 41-45 46-50 51-55 56 & over

5. Approximately how many semesters of science content courses, other than education courses, have you completed? (fill in the number of semesters)

	High School	College	Graduate
Biology	_____	_____	_____
Physics	_____	_____	_____
Chemistry	_____	_____	_____
Earth Science	_____	_____	_____
Other, specify	_____	_____	_____

6. Have you completed any elementary science teaching methods courses on the college level? (check one)

   Yes _____ No _____

7. If your answer to Question 6 was yes, check the type(s) of training in science methods that you received.

Type of Coursework	Number of Courses
a. Undergraduate coursework ___	___
b. Graduate coursework ___	___
c. Inservice workshops ___	___

8. How enjoyable do you find science teaching? (circle one number)

(extremely enjoyable) 1 2 3 4 5 6 7 8 (extremely unenjoyable)

9. In the past, how successful has your science teaching been? (circle one number)

(extremely successful) 8 7 6 5 4 3 2 1 (extremely unsuccessful)

10. Are you teaching science to your class during this school term? (check one)

Yes _____ No _____

If no, please explain why _____
and continue with Question 15 on the next page.

If your answer to Question 10 is yes, please continue with Question 11.

11. List the science units (broad topic areas) you plan to teach during this school term (fall term or spring term, not both). Next to each major unit indicate the number of weeks required to complete that unit. Use as many lines as you need.

Major Unit	Number of Weeks
_____	___
_____	___
_____	___
_____	___
_____	___
_____	___

12. When do you teach science? (check the response that best applies)

a. Five days each week ____
b. Four days each week ____
c. Three days each week ____
d. Two days each week ____
e. One day each week ____
f. One day every other week ____
g. Other (please specify) ____

_____

13. How long is your typical science lesson? _____ minutes.

14. In the average five-day week, how many minutes does the typical pupil in your classroom spend on science? _____ minutes a week.

15. In the past, before you started a science lesson, how successful did you usually expect your teaching to be? (circle one number)

(extremely successful) 1 2 3 4 5 6 7 8 (extremely unsuccessful)

16. How successful will you expect your teaching to be when you teach science in the future? (circle one number)

(extremely successful) 8 7 6 5 4 3 2 1 (extremely unsuccessful)

APPENDIX C

SCIENCE TEACHING SITUATIONS

Science Teaching Situations

Try to imagine yourself in each of the following situations. Read the four possible causes for the outcome of each situation and rate each of these causes according to how probable it is that that particular cause would be responsible for the outcome if you were the person in the situation. Be sure to rate all four causes for all of the situations as if you were actually in the situation.

Please try to be as honest and accurate in your judgments as possible. Your answers will be kept completely confidential.

Rate each cause as:

(a) extremely probable
(b) very probable
(c) moderately probable
(d) slightly probable
(e) not at all probable

You may use each letter as many times as you wish for each situation. This means you will leave out at least one choice for each situation.

Sample Situation: On a crowded bus, someone gives you a seat.

_____ people in New York are very considerate
_____ this person is getting off at the next stop
_____ you look like a senior citizen
_____ this person is an acquaintance who is trying to be polite

If there are no further questions about how to complete this questionnaire, you may start to rate the science teaching situations that follow.

A. Your class' science project is turning out very well.

___ 1. you worked hard to prepare this project
___ 2. the project is easy to do
___ 3. the project is one for which you have considerable skill
___ 4. you are lucky that several children have a special interest in this project.

B. You don't understand something you are reading in the science manual for teachers.

___ 5. you do not have the ability to understand it
___ 6. there are noises and other distractions present
___ 7. the manual is poorly written
___ 8. you are not paying close enough attention; your mind wanders.

C. You are not successful with the science unit you are now teaching.

___ 9. you are teaching a difficult topic
___ 10. you don't know the topic very well and you're not good at teaching it
___ 11. you did not work hard to prepare this unit
___ 12. your class does not happen to care about this topic.

D. Your science demonstration went very well today.

___ 13. the materials needed for the demonstration are available
___ 14. you worked hard to plan this demonstration
___ 15. you were lucky that the demonstration turned out so well
___ 16. you are good at demonstrating science concepts.

E. Your class does not seem to have learned much science this term.

___ 17. your class was distracted during the evaluation
___ 18. your science teaching was not very good
___ 19. you have a slow group of pupils this term
___ 20. you did not make a special effort to teach science.

F. Your class has won an award at the district's science fair.

___ 21. you devoted much time and effort in planning an exhibit
___ 22. it was lucky that the judges liked the topic
___ 23. it was easy to create a science exhibit
___ 24. you can present science materials in an attractive way.

G. Your pupils are not enjoying the science lesson you are teaching.

___ 25. you can't teach this topic well
___ 26. the children are not in a receptive mood today
___ 27. you are teaching a difficult topic
___ 28. you didn't attempt to prepare this lesson thoroughly

H. Someone who has observed you teaching science compliments your work.

___ 29. you are always good at teaching science
___ 30. you made a special effort to teach well that day
___ 31. this person often compliments people
___ 32. this person happened to come at a time when your lesson was going well.

APPENDIX D

PREDICTED ROLE MEASURE

(DECISIONS IN TEACHING)

Copyright 1971, Carl F. Berger

DECISIONS IN TEACHING

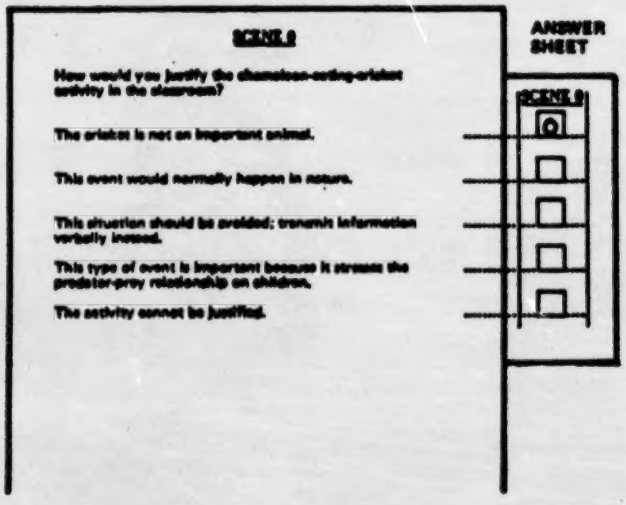
The film you will watch involves teachers making decisions during the teaching of science. At the end of certain scenes, the film will be stopped and you will be asked about possible decisions that could be made in the scene you just observed.

We would like to know your degree of agreement with each of six possible decisions for each scene. Mark a number in the box on the Answer Sheet which corresponds to your decision.

4 - agree completely
3 - agree somewhat
2 - Neither agree nor disagree
1 - disagree somewhat
0 - disagree completely

SAMPLE

As an example, a scene might be shown of a chameleon eating a cricket in a classroom terrarium. The question might be:


SCENE 8
How would you justify the chameleon-eating-cricket activity in the classroom?
The cricket is not an important animal.
This event would normally happen in nature.
This situation should be avoided; transmit information verbally instead.
This type of event is important because it stresses the predator-prey relationship on children.
The activity cannot be justified.
ANSWER SHEET
SCENE 8

© 1971, Carl F. Berger

SCENE 1

The teacher asked the question, "Are all the fish goldfish?" For what reasons would you ask this question in this situation?

To have the children discuss with one another whether or not all the fish are goldfish. ___

To have the children review their observations on the kinds of fish they saw. ___

To elicit from the children the answer that all the fish are not goldfish. ___

To help the children refine and apply their abilities to classify fish. ___

To encourage divergent responses from the children about the many kinds of organisms. ___

To determine the children's knowledge of the types of fish. ___

4 - agree completely
3 - agree somewhat
2 - neither agree nor disagree
1 - disagree somewhat
0 - disagree completely

SCENE 2

The boy asked, "What's the black stuff?" You would:

Have him present his question to the class. ___

List a few experiments he could try in order to find out what the "black stuff" is. ___

Tell him of an experiment in which he could find out what the "black stuff" is. ___

Let him select an experiment from a few he found in the book or student manual. ___

Have him ask the other children who were with him at the time of the observation. ___

Tell him the "black stuff" is detritus. ___

4 - agree completely
3 - agree somewhat
2 - neither agree nor disagree
1 - disagree somewhat
0 - disagree completely

SCENE 3

In addition to listening to responses about where the children think the "black stuff" comes from, you would:

Repeat the responses so all the children can hear. ___

Have the children react to each other's responses. ___

Have the children correct each other's responses. ___

Reward all the responses. ___

Use responses to encourage more responses. ___

Correct inaccurate responses. ___

4 - agree completely
3 - agree somewhat
2 - neither agree nor disagree
1 - disagree somewhat
0 - disagree completely

SCENE 4

The children are ready to do an experiment. You would:

Decide on the experiment after the children have presented their ideas for determining the source of the "black stuff." ___

List the children's ideas and let the children decide which to do. ___

Have the children read the experimental design in their books. ___

List a number of experiments and let the children decide from your list of experiments. ___

Tell the children the design of the experiment they are to do. ___

Allow the children to experiment freely to determine the source of the "black stuff." ___

4 - agree completely
3 - agree somewhat
2 - neither agree nor disagree
1 - disagree comewhat
0 - disagree completely

SCENE 5

The children do not agree on the number of containers. You would:

Question the children until a number evolves from the class. ___

Tell the children how many containers they will need. ___

Show the children the number of containers listed in the book or student manual. ___

Allow the children to discuss the problem among themselves and decide. ___

Allow each child to decide on the number of containers he would like to use. ___

List the possible numbers of containers and let the children vote. ___

4 - agree completely
3 - agree somewhat
2 - neither agree nor disagree
1 - disagree somewhat
0 - disagree completely

SCENE 6

The teacher is distributing soil individually to each child. What distribution technique would you use?

Have the children go to stations to get the soil. ___

Have the children go one at a time to the science kit to get the soil. ___

Have each child come to you to get the soil. ___

Walk around the room giving out the soil. ___

Have monitors go to stations around the class to get enough soil for their groups. ___

Give monitors the soil for each group. ___

4 - agree completely
3 - agree somewhat
2 - neither agree nor disagree
1 - disagree somewhat
0 - disagree completely

SCENE 7

When the boy asks the teacher what would happen when the vial gets full of fruit flies, you would:

Have him present this question to the class. ___

List a few experiments he could try in order to find the answer. ___

Tell him to leave the top on to discover the answer. ___

Let him select from a few experiments he found in the book or student manual. ___

Have him ask the other children around him. ___

Tell him what would happen. ___

4 - agree completely
3 - agree somewhat
2 - neither agree nor disagree
1 - disagree somewhat
0 - disagree completely

SCENE 8

The chameleon is being transferred to a terrarium. You would:

Select a child to handle the chameleon. ___

Allow all the children to handle the chameleon. ___

Transfer the chameleon yourself. ___

Ask for a volunteer to transfer the chameleon. ___

Make the chameleon available for any child who wishes to transfer or handle it. ___

Wear plastic gloves and then transfer the chameleon. ___

4 - agree completely
3 - agree somewhat
2 - neither agree nor disagree
1 - disagree somewhat
0 - disagree completely

SCENE 9

After introducing the terms "predator" and "prey", you would:

Have the children question each other on their understanding of the predator-prey relationship. —

Have the children read textbooks that give examples of the predator-prey relationship. —

Have the children search for examples of predators and prey from their experiments. —

Describe examples of the predator-prey relationship. —

Have the children give examples of predators and prey from their past experiences. —

Have the children discussion the predator-prey relationships with each other in small groups. —

4 - agree completely
3 - agree somewhat
2 - neither agree nor disagree
1 - disagree somewhat
0 - disagree completely

APPENDIX E

INSTRUCTIONS TO THE PARTICIPATING TEACHERS

INSTRUCTIONS TO THE TEACHERS PARTICIPATING IN THE RESEARCH IN SCIENCE EDUCATION

Introduction

I want to thank all of you for coming here today. As you already know, we are conducting research in science education. Most research in science teaching has been concerned with organizing concepts and subject matter in terms of the needs of children. However, less is known about the teacher's role in the way science is presented. Your participation in this research will add to our knowledge about teachers' preferences when teaching science.

We are now about to begin. This study will require you to respond to items in a booklet consisting of four questionnaires. No decisions will be made about you that is based on the results of this research. In fact, information about individuals will not be totalled and will not be released. However, information provided by each individual is important in affecting the group results.

In order for this information to be useful, it is essential that you provide every answer called for in the questionnaires. Please check periodically to make sure that you are completing every part of these forms. You will be given enough time to do so.

Please do not discuss the items on these questionnaires with others as this is part of a larger study that will be continuing in other school districts.

I know you may want to ask questions as we go along. In the interests of finishing on time and so that no one will be detained, I will ask you to save your questions until the very end. While this session is in progress, you should ask questions only if they relate directly to the printed items. At the end of the session I will stay around to answer any other questions and refreshments will continue to be available.

Please answer the items in a way that reflects your honest reactions. For most of the questions, there will be no single answer that is correct.

(BOOKLETS WILL BE DISTRIBUTED AT THIS POINT)

The top page on the booklets is a COVER SHEET. Please copy the number on your card in the space marked TEACHER NUMBER. Then fill in the school in which you teach and the school's address. You will be receiving a check for completing these questionnaires. You may also want to receive a summary of the findings of this research when they become available. If you would like your check and summary to be mailed to you at your school, write SAME next to the mailing address. If you prefer that these reach you elsewhere, please enter the mailing address in the space provided.

Introduction to Part I: Teacher Background Information

You are now about to begin the first part which is called Teacher Background Information. Please raise the cover sheet and copy your teacher number in the space provided. Please begin.

(SUBJECTS TAKE PART I AT THIS TIME)

When you have finished, please put your pen down and look up. Has everyone finished? We will now turn to the next part.

Introduction to Part II: Science Teaching Situations

The second part of this booklet is called Science Teaching Situations. Please turn to the first page of that questionnaire, and enter your teacher number in the space provided.

Try to imagine yourself in each of the following situations. Read the four possible causes for the outcome of each situation and rate each of these causes according to how probable it is that that particular cause would be responsible for the outcome if you were the person in the situation. Be sure to rate all four causes for all of the situations as if you were actually in the situation.

Please try to be as honest and accurate in your judgments as possible. Your answers will be kept completely confidential.

Rate each cause as:

a. extremely probable

b. very probable

c. moderately probable

d. slightly probable

e. not at all probable

You may use each letter as many times as you wish for each situation. This means that you will leave out at least one choice for each situation. Let us try the sample item together.

Please rate each of the four causes following Situations A through H so that you complete all 32 items.

(SUBJECTS TAKE PART II AT THIS TIME)

Please indicate that you have finished by placing your pen on the desk and looking up. Remember to look through your answers to make certain that every part has been filled in. Does anyone need more time?

Introduction to Part III: Science Content

Part III is to be completed in 15 minutes. Try to answer as many questions as you can. (Read instructions from ETS.) Please begin now.

(SUBJECTS TAKE PART III AT THIS TIME)

Please stop even though you might not have completed Part III. Turn to the next booklet.

Introduction to Part IV: Decisions in Teaching

The last part, Decisions in Teaching, consists of a color film and a questionnaire. The film involves teachers making decisions during the teaching of science. Think of yourself as if you were the teacher in the film. Think of the pupils in the film as being children in your own class. At the end of certain scenes the film will be stopped and you will be asked about possible decisions that could be made in the scene just observed. The questionnaire has nine pages corresponding to the nine scenes in the film.

We would like to know your degree of agreement with each of the six possible decisions for each scene. After each response, place an "X" in the agreement-disagreement box for each decision that indicates your degree of agreement with each decision.

Consider each response on a page as independent from all other responses on that page. It is possible to agree with all the items on each page; to disagree with all the items on each page; or to have a combination of agreement and disagreement with the items. If you do not agree or disagree with an item you may mark the center or neutral cell of that item. It is important that you complete every item.

Let's try the sample page together. As an example, the film might show a scene of a chameleon eating a cricket in a classroom terrarium.

(SUBJECTS WILL LOOK AT THE COVER SHEET OF DECISIONS IN TEACHING AND DO THE SAMPLE ITEM. THE FILM WILL THEN BE PROJECTED.)

That's it! Please check over the cover sheet and the top page of each questionnaire to make sure that the correct Teacher Number has been entered. Please make sure that your name and address are correct. A check will be in the mail to you within the next two weeks. I want to thank you again for your cooperation and assistance. If you have any questions, I will be happy to answer them.

ELEMENTARY TEACHERS' ATTRIBUTIONAL STYLES AND THEIR SCIENCE TEACHING PERFORMANCE

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Purpose

The purpose of the present study was to investigate elementary school teachers' attributional styles in relation to two indicators of their science teaching performance: teaching method and allocation of time. The following research questions were addressed:

1. How do teachers attribute the causes of success or failure in their science teaching?

2. Does the attributional model help explain science teaching performance in elementary school teachers?

3. Are the attributional variables predictors of science teaching performance?

Results and Conclusions

Teachers' attributional styles. Teachers attributed successful teaching to effort and ability (internal attributions) more than to the task or luck (external attributions); however, unsuccessful teaching was attributed more externally than internally. Although the teachers' preference for internal attributions was significantly stronger in success than in failure, their attributions to external

causes were not changed by success or failure outcomes. The teachers also preferred unstable attributions when they were successful, but they had no significant preference for the stability of their attributions when they were unsuccessful. Therefore, the results indicate that teachers have distinct attributional styles when explaining the outcomes of their science teaching performance.

The attributional model. Significant relationships obtained between attributional variables were generally of a low order of magnitude. However, the teachers' perceptions of their past success in science teaching were moderately related to their attributions to ability in success situations and to their enjoyment of science teaching. Other predictions of the attributional model were generally not supported.

The predictors of science teaching performance. There were two positive predictors of time allocation: (1) the number of science teaching methods courses completed, and (2) the attribution of successful science teaching to ability. However, greater time allocation was negatively predicted by attribution of failure to lack of effort. In addition, the student-emphasis teaching method was predicted by the teachers' expectancy to improve in future science teaching. These predictors, however, accounted for only a small fraction of the variance in science teaching performance. Thus, it appears that the teachers' causal cognitions and their preparation to teach science are not important predictors of their own performance.

VITA

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